

12.2023

NATIONAL
GEOGRAPHIC

PICTURES

OF THE YEAR

THE WONDER OF
OUR WORLD IN 29 PHOTOS





ROLEX AND NATIONAL GEOGRAPHIC
PERPETUAL PLANET AMAZON EXPEDITION



DAWA YANGZUM SHERPA,
INTERNATIONAL
MOUNTAIN GUIDE



FRANCESCO SAURO, EXPLORER



CRISTIAN DONOSO, EXPLORER



GHISLAIN BARDOUT
EXPLORER



WHAT DO THEY SEEK?

Explorers, adventurers, scientists. Men and women who always broadened the horizons, for all humankind to share. Rolex was at their side when they reached the deepest point in the oceans, the highest summits of the Earth, the deepest jungles and both poles. But now that we know, more than ever, that our world has its limits, why do they continue to venture out there, again and again?

Certainly not for kudos, accolades, or an ephemeral record. What they truly seek is to understand more intimately how complex and delicate our planet is, to document its change and how together, we can affect it for the better. So as long as they need it, we will be at their side. Because today, the real discovery is not so much about finding new lands. It's about looking with new eyes at the marvels of our planet, rekindling our sense of wonder, and acting to preserve our pale blue dot in the universe...

Doing our very best for a Perpetual Planet.

#Perpetual



OYSTER PERPETUAL
SUBMARINER DATE



CONTENTS

On the Cover

A banded sea krait swims toward the surface for a breath of air at Blue Corner, a spectacular scuba diving site in Palau's Rock Islands Southern Lagoon.

KILIII YÜYAN

PROOF



8

Into the Woods

By using a camera-mounted microscope, a photographer zooms in on the branches, pine cones, and plants of a Canadian forest—down to their cells.

PHOTOGRAPHS BY
ROBERT BERDAN

EXPLORE

17

THE BIG IDEA

Exposing Hidden Marvels

Through specialized techniques, photography can teach us to see the world in new ways.

BY ANAND VARMA

FIELD NOTES

Circling the Globe in Search of the Past

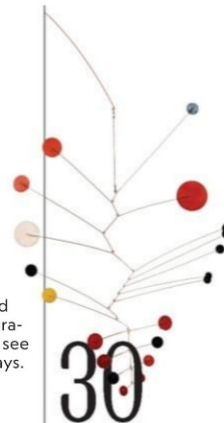
Albert Lin, an adventurous engineer, seeks telling remnants of former civilizations.

BY DANIEL STONE



ALSO

Following the Fish
Wild Flora at Risk



TRAVEL RADAR

Where to Go Now

See Calder mobiles in Seattle, a rainforest reserve in Cameroon, and a top view of a royal city in Vietnam.

BY RONAN O'CONNELL

THROUGH THE LENS

Reprieve for Tigers

A grueling investigation into America's captive tiger industry ends with a ray of hope.

BY STEVE WINTER, WITH
SHARON GUYNUP

ALSO

Pompeian Delicacies
Armored Bird Nests



FEATURES

Pictures of the Year

Diana Markosian's portraits of young women who are shaking things up in Somaliland, Renan Ozturk's capture of an expedition vessel nearly swallowed by the seas of the South Atlantic—these are just a few of the most memorable images made by National Geographic photographers around the world in 2023.

.....P. 36

Fortress of Faith

Get an insider's view of Spain's Alhambra.

BY EMMA LIRA

PHOTOGRAPHS BY

JOSÉ MANUEL NAVIA

ART BY FERNANDO G.

BAPTISTA

.....P. 88

Where Have All the Caribou Gone?

Once robust herds are rapidly declining.

BY NEIL SHEA

PHOTOGRAPHS BY

KATIE ORLINSKY.....P. 112

ABOVE: Marcio Pimenta photographed this taxidermied Darwin's rhea at the Maggiorino Borghatello museum in Chile while on a solo expedition following the trail of Charles Darwin. Using the naturalist's travel journal as his guide, and with support from the National Geographic Society, Pimenta covered more than 6,835 miles of land and sea.

Reliability. Efficiency. Value. That's what we're made of.

We're building a better Postal Service,
so you can share even more holiday joy.



Fulfill your holiday shipping needs
at usps.com/holidays

©2023 United States Postal Service®. All Rights Reserved.
The Eagle Logo is among the many trademarks of the U.S. Postal Service®.



DELIVERING
FOR AMERICA™



BY **NATHAN LUMP** PHOTOGRAPH BY **NICHOLE SOBECKI**

AT NATIONAL GEOGRAPHIC we are fortunate to work with incredible photographers who canvass the globe to uncover stories that give us a new understanding of our world. Every day our team of skilled photo editors and designers combs through their images (sometimes thousands for a single story!) to choose the ones that do what great photographs do: convey information, yes, but also compel the eye and fill the heart.

Our annual tribute to this work, "Pictures of the Year," highlights a selection of our editors' favorite images from photographers in the field. It is not meant to tell a story of the year's most important moments, but to show what the world, in all its variety and richness, looked like

to our contributors. Perhaps unsurprisingly, you'll still find in these photographs many of the themes that are on all our minds: the shadow of war, the impact of climate change, the push-pull of modernity and tradition, the promise of science.

Also in our pages this month: an in-depth survey of the iconic Alhambra in Spain, featuring a spectacular graphic exploration of the site by *National Geographic* senior artist Fernando Gómez Baptista, and an examination of North America's great caribou herds, which have been experiencing a precipitous decline that is not entirely understood.

We hope you enjoy the issue.

One of the most captivating images from the past year was this Egyptian fruit bat flapping its wings inside a wind tunnel at Brown University. In her lab, biologist Sharon Swartz studies the biological and physical aspects of flight in various bat species.

Subscriptions For subscriptions or changes of address, contact Customer Service at ngmservice.com or call 1-800-647-5463. Outside the U.S. or Canada call +1-515-237-3674.

Contributions to the National Geographic Society are tax deductible under Section 501(c)(3) of the U.S. tax code. Copyright © 2023 National Geographic Partners, LLC. All rights reserved. National Geographic and Yellow Border: Registered Trademarks © Marcas Registradas. National Geographic assumes no responsibility for unsolicited materials. Printed in U.S.A. For corrections and clarifications, go to natgeo.com/corrections.

NATIONAL GEOGRAPHIC (ISSN 0272-2526) PUBLISHED MONTHLY BY NATIONAL GEOGRAPHIC PARTNERS, LLC, 1771 ST. NW, WASHINGTON, DC 20036. \$49.00 PER YEAR FOR U.S. DELIVERY, \$56.00 TO CANADA, \$69.00 TO INTERNATIONAL ADDRESSES. SINGLE ISSUE: \$6.00 U.S. DELIVERY, \$9.00 CANADA, \$16.00 INTERNATIONAL. (ALL PRICES IN U.S. FUNDS; INCLUDES SHIPPING AND HANDLING.) PERIODICALS POSTAGE PAID AT WASHINGTON, DC, AND ADDITIONAL MAILING OFFICES. POSTMASTER: SEND ADDRESS CHANGES TO NATIONAL GEOGRAPHIC, PO BOX 37545, BOONE, IA 50037. IN CANADA, AGREEMENT NUMBER 1000010298. RETURN UNDELIVERABLE ADDRESSES TO NATIONAL GEOGRAPHIC, PO BOX 899 STN MAIN, MARKHAM, ONTARIO L3P 9Z9. UNITED KINGDOM NEWSTAND PRICE £6.99. EDITOR: RESIP. POUR LA BELGIQUE: MARCO PROVASI-EMD BELGIUM SA, RUE DE GRAND BIGARD 14 - 1010 BRUXELLES - BELGIUM. SAINT AGATHE, REP. EN FRANCE: EMD FRANCE SA, BP 1028, 92011 LILLE CEDEX, TEL. 33(0)303302 CPPAP 072089037. DIRECTEUR PUBLICATION: D. TASSINARI, DIR. RESP. ITALY: RAPP. EMD SRL, VIA G. DA VELATE 11, 20162 MILANO, AUT. TRIB. MI 258 26/5/84 POSTE ITALIANE SPA, SPED. ABB. POST. DL 353/2003 (CONV. L.27/02/2004 N.46) ART. 1 C. 1 DCB MILANO STAMPA, QUAD, MARTINSBURG, WV 25401. SUBSCRIBERS: IF THE POSTAL SERVICE ALERTS US THAT YOUR MAGAZINE IS UNDELIVERABLE, WE HAVE NO FURTHER OBLIGATION UNLESS WE RECEIVE A CORRECTED ADDRESS WITHIN TWO YEARS.

An underwater photograph of a diver in a blue wetsuit and scuba gear, swimming towards a coral reef on the right. Sunlight rays penetrate the blue water from the top. The title 'MERMAIDS ARE REAL' is centered in white capital letters.

MERMAIDS ARE REAL

| SYLVIA EARLE |

With over 7,000 hours spent underwater as part of a lifetime of research, exploration, and conservation efforts, Sylvia Earle isn't just oceanic royalty. She's the closest thing we've got to a real-life mermaid. Explore the world alongside National Geographic Experts like Sylvia when you make your next trip an expedition.



NATIONAL
GEOGRAPHIC
EXPEDITIONS

NATGEOEXPEDITIONS.COM | 1-888-351-3274

© 2023 National Geographic Partners, LLC. National Geographic EXPEDITIONS and the Yellow Border Design are trademarks of the National Geographic Society, used under license.



Neil Shea

Based in Brooklyn, New York, Shea is an award-winning writer who works in print, film, television, and audio. He covers cultural and environmental shifts in places from Iraqi Kurdistan to East Africa. His book *Frostlines: Dispatches From the New Arctic* will be published by Ecco in 2025. **Page 112**



Emma Lira

A travel writer and specialist in Spain, Lira has authored historical fiction novels, a Lonely Planet Granada guide, and a *National Geographic* story on Tenerife's mummies. She's a resident of Madrid and the Canary Islands and leads small group tours for women throughout the Islamic world. **Page 88**



José Manuel Navia

Navia's images highlighting aspects of Iberian, Hispanic, and Andalusian cultures appear regularly in *El País* and have been featured in the Spain edition of *National Geographic* for 25 years. His photographic essays are often based on authors he admires, capturing their literary landscapes. **Page 88**

NATIONAL GEOGRAPHIC EXPLORERS

These contributors have received funding from the National Geographic Society, which is committed to illuminating and protecting the wonder of our world.



Katie Orlinsky

During almost a decade of living in and visiting Alaska, Orlinsky has been examining the effects of climate change on the Arctic. Her images of its thawing permafrost appeared in the September 2019 issue of *National Geographic*, and for this issue she hiked solo for days in a remote stretch of Alaska to document migrating caribou. When a wolf approached briefly, Orlinsky was thrilled for the company, she says. The June 2023 cover story featured her photographs of the world's first designated wilderness area, in New Mexico. She became an Explorer in 2022. **Page 112**



Anand Varma

In the woods near his childhood home in Atlanta, Varma discovered his passion for being immersed in the natural world. Then he picked up his father's camera and found a way to share that enthusiasm. Now living in Berkeley, California, Varma has spent years developing innovative photography techniques to reveal aspects of science and nature, such as the rapid motions of hummingbirds, that normally go unseen. An Explorer since 2010, he's also a TED speaker and a World Press Photo award winner. **Page 17**

The following Explorers contributed photographs to "Pictures of the Year," beginning on page 36:

David Doubilet, Yagazie Emezi, Jen Guyton, Robin Hammond, Davide Monteleone, Matthieu Paley, Louie Palu, Thomas Peschak, Carsten Peter, Marcio Pimenta, Jaime Rojo, Alexander Semenov, Chinky Shukla, Nichole Sobecki, John Stanmeyer, Brent Stirtor, and Kiliii Yüyan.



GIFT IDEAS FOR
THE ADVENTURER!



AV
f

IC
LLC

Calls and notifications will vibrate

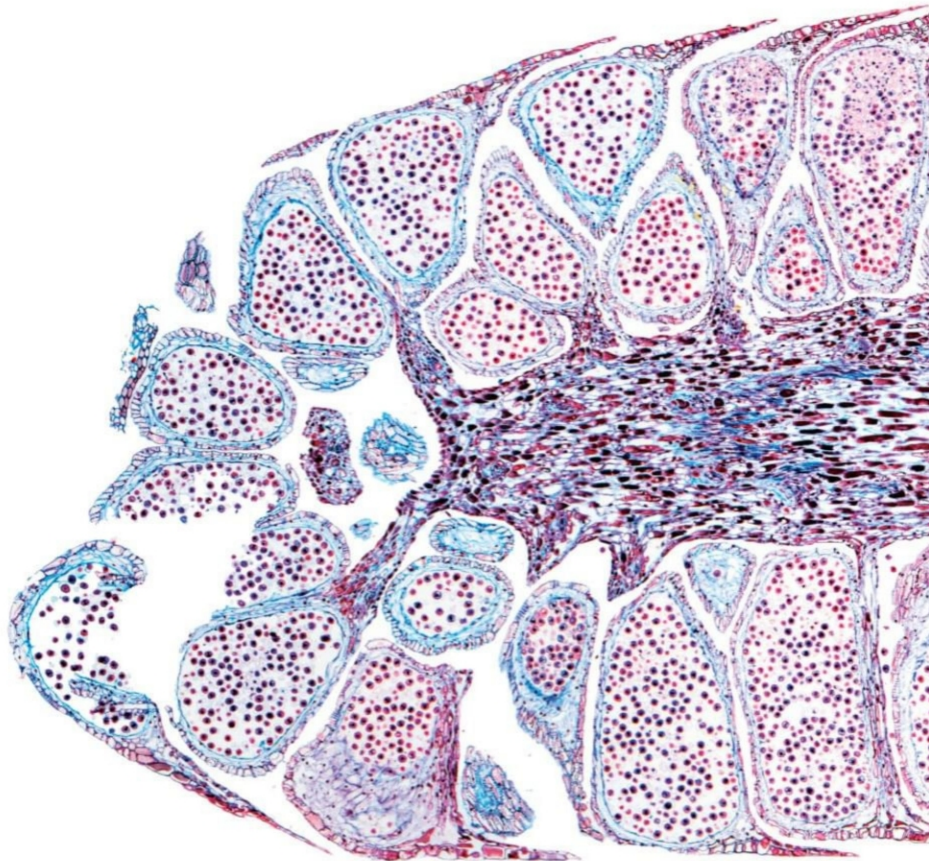
PROOF

NATIONAL GEOGRAPHIC



PHOTOGRAPHS BY **ROBERT BERDAN**

LOOKING AT THE EARTH FROM EVERY POSSIBLE ANGLE



8 NATIONAL GEOGRAPHIC

ARTICLE

INTO THE WOODS

With a camera-mounted microscope, this photographer reveals the cellular world inside a forest.

VOL. 244 NO. 6

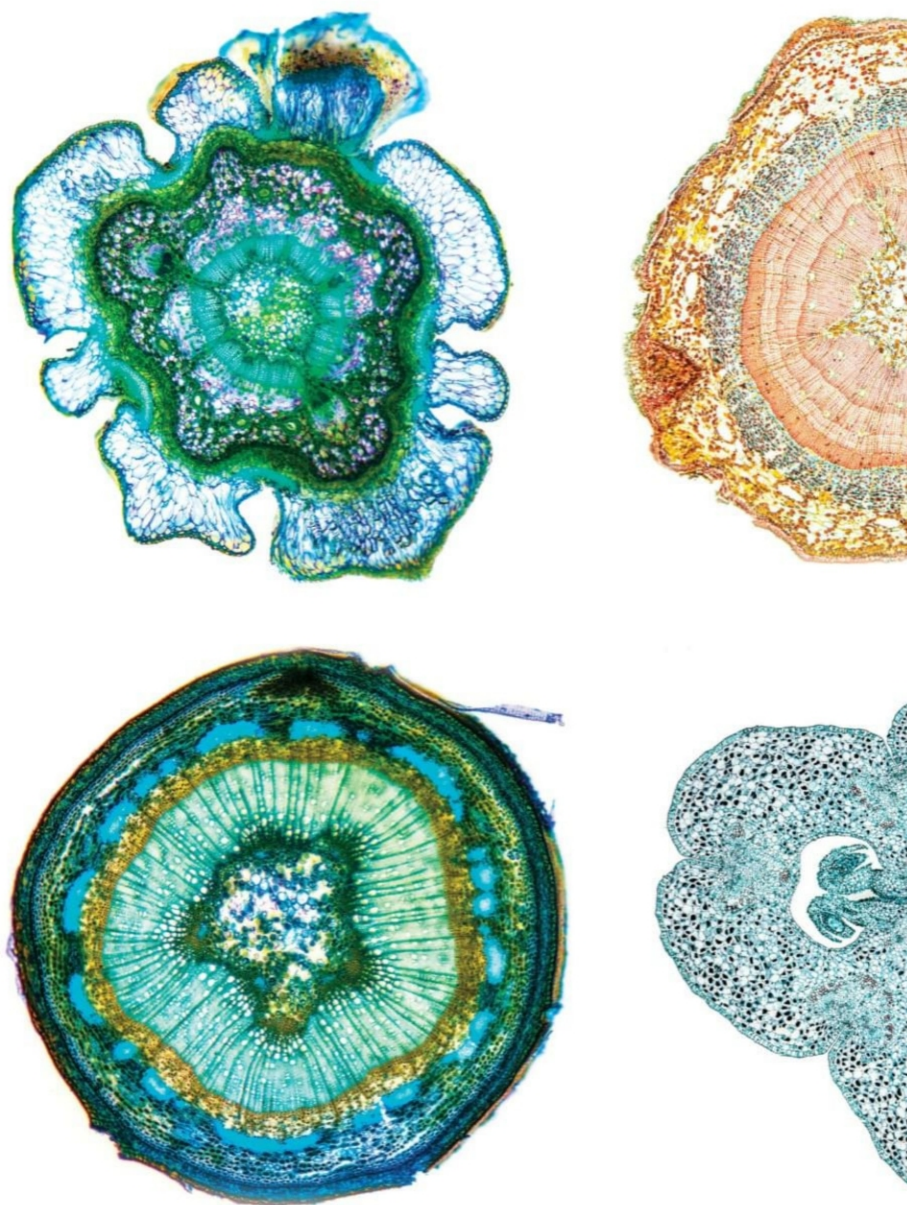


Red and blue dyes isolate parts of the interior of a male pine cone, sliced lengthwise and magnified 20 times. Pollen-filled sacs surround the pine cone's central axis.

DECEMBER 2023 9

ARTICLE

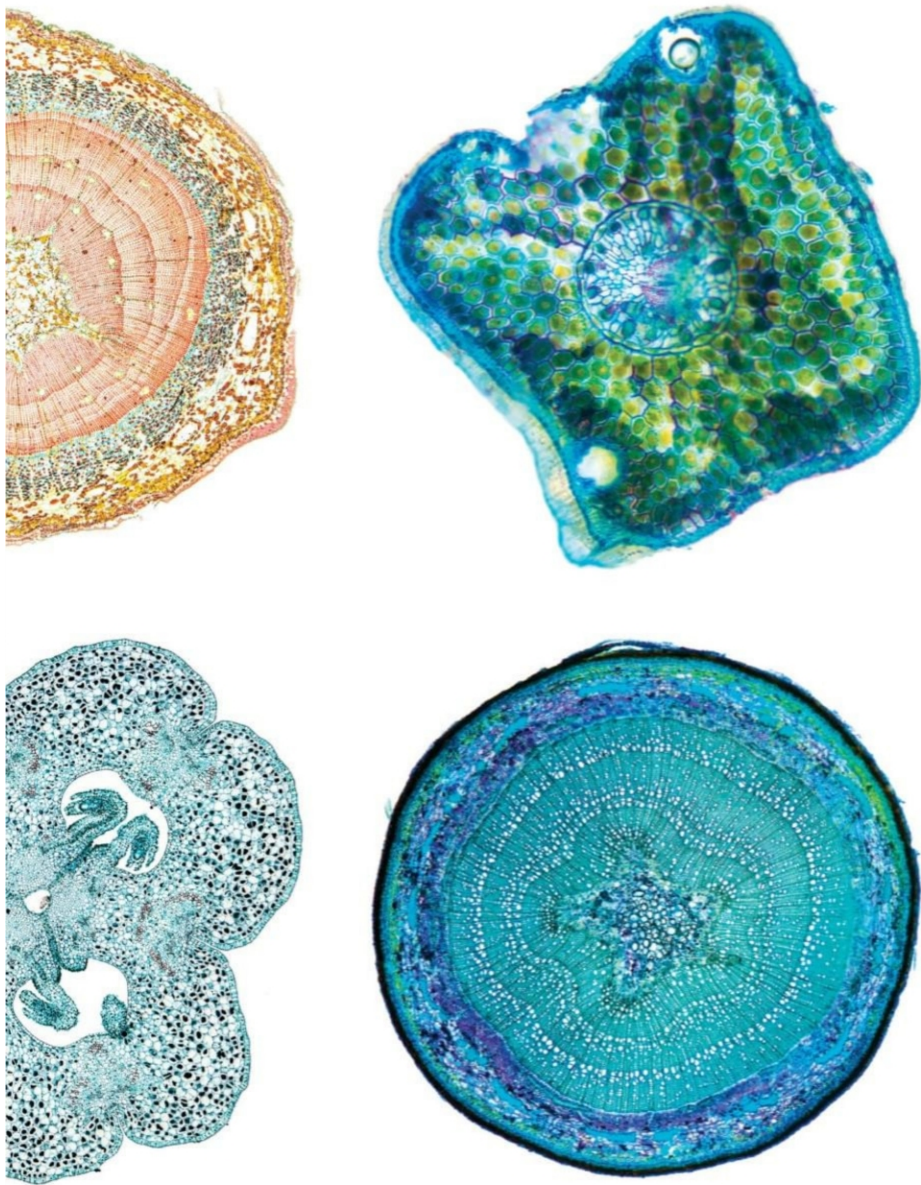
PROOF



In Robert Berdan's lab, tinted slices of plants transform into kaleidoscopic works of art echoing agate or stained glass. His technique, known as photomicrography, involves photographing dyed specimens under a microscope fitted with a DSLR camera.

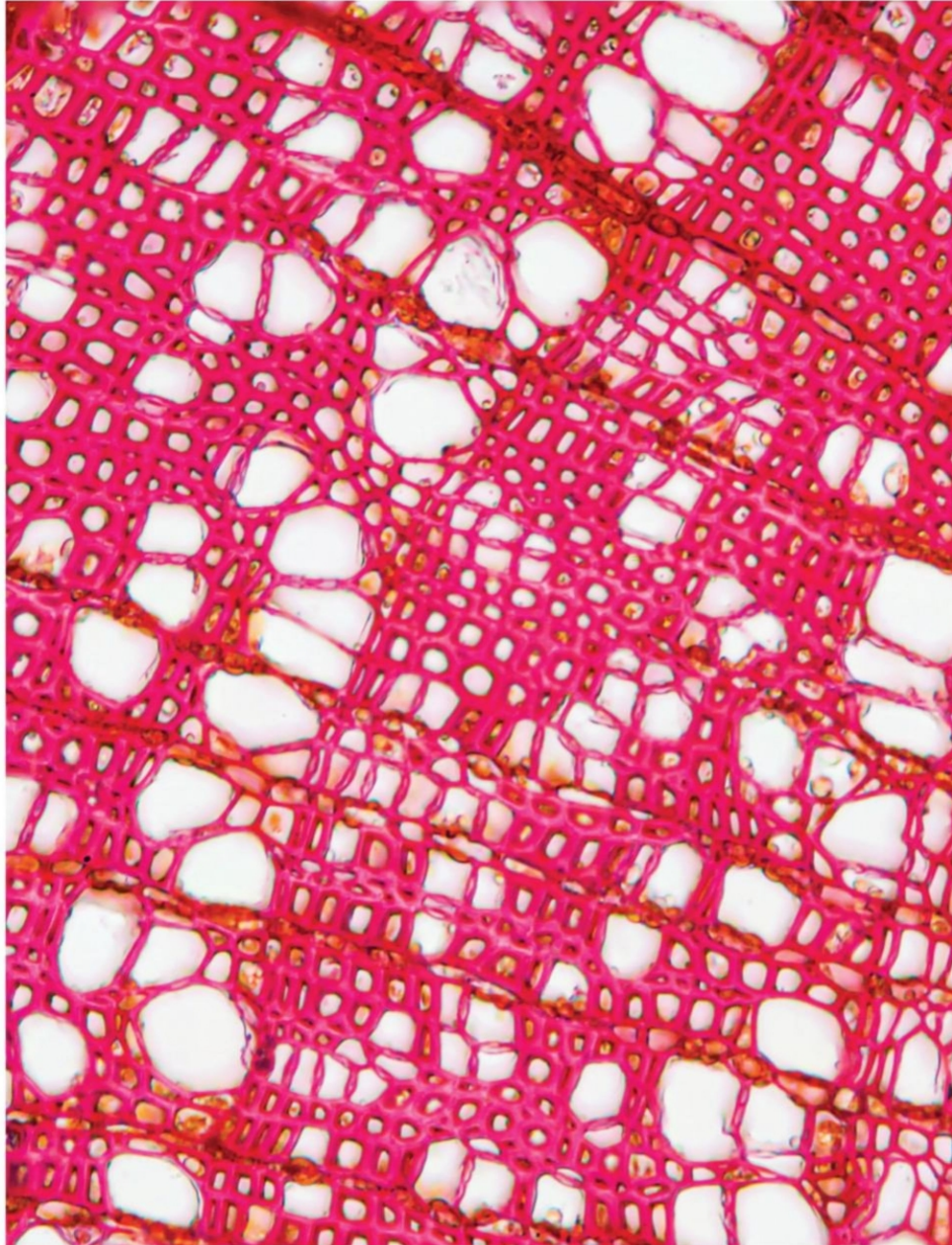
10 NATIONAL GEOGRAPHIC

ARTICLE



Seen here, clockwise from top left: spruce branch; pine stem, showing four distinct growth rings; spruce needle; poplar branch; brown lily ovary; poplar branch at greater magnification.

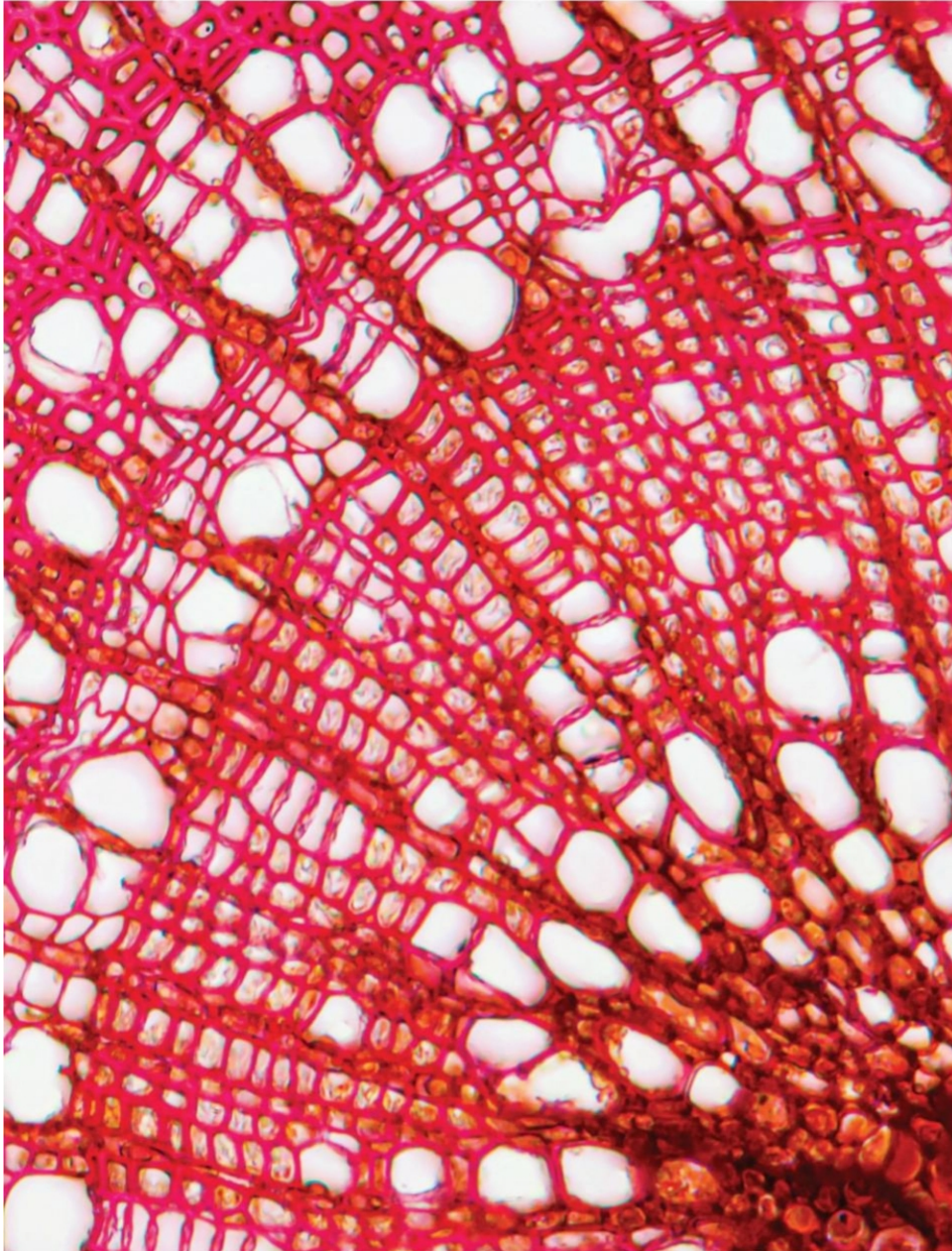
PROOF



Thinly sliced, tinged with red, and photographed at 400 times magnification, a poplar branch calls to mind not wood but macramé. "I became interested in photography because I wanted to share what I saw in the microscope," Berdan says. In this

12 NATIONAL GEOGRAPHIC

ARTICLE



image, parenchyma cells, which are the foundation of all plant tissue, resemble holes, while a banding pattern reflects the tree's annual growth. "Plants are more complicated than most of us imagine," he says.

DECEMBER 2023 13

ARTICLE

THE BACKSTORY

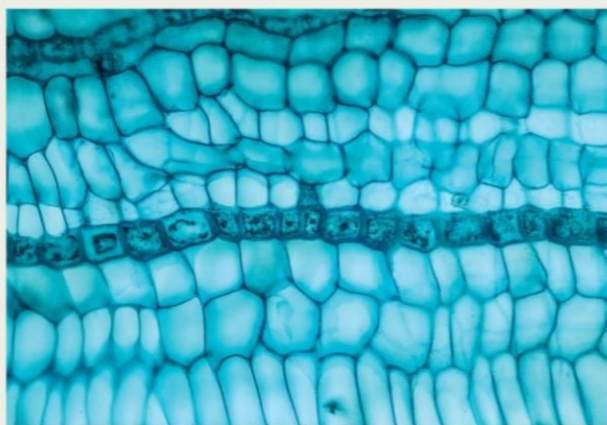
AS A CHILD, THIS PHOTOGRAPHER GOT A CLOSE-UP LOOK AT THE NATURAL WORLD. HE'S BEEN ENTHRALLED EVER SINCE.

GROWING UP ON the shores of Lake Huron in the Canadian province of Ontario, Robert Berdan was never far from water. When he was in sixth grade, he received a toy microscope for Christmas. Some of the first things he saw through its lens were tiny creatures inside droplets he'd gathered from a local pond. He was fascinated with the microorganisms.

After eighth grade, Berdan upgraded to a more sophisticated model and realized it was a portal to another world. "The new microscope changed my life," he says. "I could see so much more." He began studying photography and buying cameras to fit on his microscope. He captured images of ferns, mushrooms, and trees, and learned how to develop film. He also developed his microscopy skills, so much so that he earned a doctoral degree in cellular biology and spent five years running a lab at the University of Alberta in Edmonton.

But Berdan never forgot his two early passions—being immersed in nature and photographing its tiny details—and he decided to return to them. His subjects range from snowflakes to spruce trees. To see the latter under a microscope, Berdan collects a small branch and wields specialized tools to shave off paper-thin slices, which he dyes red or blue. For the final images, he often uses a process called focus stacking, in which similar photos with different focal planes are blended to achieve a more profound depth of field, and he sometimes stitches photos together to create panoramas.

"I investigate anything that might have possibilities," he says. And he encourages others to do the same with a microscope. "Any tool that amplifies our ability to see will enhance our creativity," he notes. "Our observations can potentially lead to new discoveries and solutions." —CATHERINE ZUCKERMAN



Blue pigment adds an icy hue to this view of the cellular structure within a poplar branch.

EXPLORE

IN THIS SECTION

Pizza in Pompeii?
Wild Plants to Know
Calder Extravaganza
On the Tiger Beat



ILLUMINATING THE MYSTERIES—AND WONDERS—ALL AROUND US EVERY DAY

NATIONAL GEOGRAPHIC

VOL. 244 NO. 6

Exposing Hidden Marvels

WITH ITS ABILITY TO CAPTURE SIGHTS INDISCERNIBLE TO THE HUMAN EYE, PHOTOGRAPHY CAN 'TEACH US TO SEE THE WORLD ANEW.'

BY ANAND VARMA

A

AS A KID, I DREAMED of becoming a marine biologist and living my life by the sea. Since I grew up in a landlocked suburb of Atlanta, I lived out this fantasy by setting up aquariums at home. At 14, I started working at my neighborhood aquarium shop. By 16, I had seven fish tanks at home. Then, at 20, I was introduced to photographer David Liittschwager, who hired me to help him with a *National Geographic* magazine assignment on marine life.

We spent 10 days aboard the *Oscar Elton Sette*, a 224-foot NOAA research vessel sailing off the Kona coast of Hawaii. David's assignment was to document the astounding biodiversity found at the surface of the ocean. My role was to collect specimens for him to photograph.

Every night after the *Sette* had completed its scientific mission, I would cast a floating lamp off the port side of the ship. Like moths drawn to a flame, mysterious creatures would emerge from the depths

DECEMBER 2023 17

ARTICLE

in search of this light. Shimmering baby eels, tiny transparent crabs, sparkling squid. I'd carefully select an ambassador for each species and set up aquariums to house them as they waited for David to take their glamour shot.

Those evenings aboard the *Sette* made me feel as if I were on another planet. At the end of each night, I'd sit and marvel at my dazzling collection. I had never imagined such bizarre life-forms could exist in our oceans. My eyes were glued to the tanks, my attention absorbed by these alien beings. But I didn't grasp the true magic of what was in front of me until I saw the photographs David took of these creatures I'd been gathering.



A macro lens, fast shutter speed, and precise lighting brought out dazzling details in this young flounder that weren't initially apparent.

The biggest surprise was his image of a baby flounder, seen above. I caught this fish by accident, scooping it up as I was chasing some more obvious target. Only later, when I inspected the contents of my collecting jar, did I notice its two tiny eyeballs staring back at me. The only other feature I could discern was the faintly wriggling outline of its transparent body.

But David's photograph of this flounder revealed a universe of detail that even my eager eyes had missed. His macro lens magnified its finely articulated ribs. The lightning-fast exposure froze its motion, providing a crisply defined view. A precisely aimed light released the rainbow hidden in the flounder's skin. And the black background eliminated all distractions to focus our attention on the quiet beauty at hand.

Years after that project in Hawaii, I was snorkeling at night on a shallow reef in French Polynesia. Out of the darkness, another baby flounder emerged and settled on my mask. This time I knew what to look for. I angled my flashlight toward the little fish and

saw the shimmering colors and delicate bones that David's image had first revealed to me.

Before working for David, I had assumed the goal of photography was simply to reproduce an observation so that others could share the same experience. It had never occurred to me that photography could expand our visual perception and thereby teach us to see the world anew.

SIZE. TIME. LIGHT. FOCUS. These are the features of David's photograph that expanded my understanding of that small flounder. And these are the tools that photography gives us to witness and reveal the world's invisible wonders.

For example, size. When editors at *National Geographic* asked me to photograph a story on honeybees, I was not excited to take on the assignment. The tiny pollinators had already garnered so much media attention that I couldn't imagine how I could contribute anything new. But as an insecure young photographer, how could I say no? So I faked some enthusiasm and landed a job I had no idea how to accomplish.

I started by learning how to keep bees in my Berkeley, California, backyard, hoping that with enough time and study, I'd discover some new way of portraying their lives. One day I noticed something out of place: A young bee had become trapped as it was emerging from the hive. Using a trick I'd learned from an entomologist, I plucked one of my eyelashes and used its thin, flexible tip to brush a bit of debris away from the bee's face. Then I placed a light behind the hive to make the surrounding wax glow.

The bee's position allowed me to bring my camera close and capture features on its head I hadn't noticed before, like its jointed antennae and furry face. I'd spent a year tending to my hive—but until that moment I'd never experienced a bee this way. Once we were brought eye to eye, the intimacy inspired new questions. How does this creature perceive its environment? What do I look like to it? Why all the hair?

We tend to relate best to beings our own size, or at least creatures we can see with an unaided eye. When photography magnifies a subject, it can break that barrier. That opens us to entirely new perspectives.


THERE'S SIMILAR POTENTIAL in time. In 2015 I met bat expert Rodrigo Medellín in Mexico's Yucatán Peninsula, where his team had located a family of woolly false vampire bats, one of the largest species in the Americas. *National Geographic* wanted me to photograph the bats, and Medellín asked me to bring an enclosure so we could work with them in captivity. I brought a collapsible batting cage used for

PHOTO: DAVID LIITTSCHWAGER



**THERE'S A BETTER WAY
TO SHOW YOUR LOVE.**

Show your love with the delicious real chicken and fresh vegetables of Cesar® Wholesome Bowls™.

 Love them back™



© 2023 Mars or Affiliates

A COMPELLING PHOTOGRAPH
CAN CHANGE US. IT SHAPES
WHAT WE NOTICE, CHALLENGES
OUR ASSUMPTIONS, AND
EXPANDS OUR CURIOSITY.

baseball practice and set it up at the foot of my hotel room bed. We then released a captured bat inside.

Bats' speed and stealth make them nearly impossible to track with a camera. But Medellín used a clever technique of enticing the carnivore to fly across the cage on command, using bits of raw chicken as a reward, and that allowed me to predict where it would be and when. I set the camera to take an image over a third of a second, knowing this would record only a blurry trace of the bat's swift movement. But before the camera completed its exposure, I triggered a brief flash of light, creating a crisply defined image of the bat superimposed onto its impressionistic form.

We often assume a photograph can capture only a single moment, yet that image simultaneously illustrates two different time intervals—in a sense, one too fast for us to see and the other too slow. Our natural perception lies somewhere in between, as a series of moments strung together into a movie whose pace we cannot change. Photography gives us unique and flexible means to explore and portray time's passage.

AS FOR LIGHT, see how fog transforms traffic signal beams in Lucas Zimmermann's long exposure, shown at right. Every photograph is a collaboration with light. Photographers position light in clever ways or manipulate it to reveal hidden patterns. Using cameras' capacities to detect colors invisible to the human eye, they broaden our sensory experience.

And focus? Broadly defined, focus is how photographers direct our attention, with technical skill and thoughtful composition that compel us to slow down and consider the layers of complexity and detail in a scene that we might miss at first glance.

When I first decided to pursue photography, I thought I'd have to abandon my childhood dream of being a scientist. But the longer I work in both realms, the better I understand how each reinforces the other. That's the principle behind WonderLab, a research center I recently established (see sidebar).

I believe a compelling photograph can change us. It shapes what we notice, challenges our assumptions, and expands our curiosity. It motivates us to make room for new ideas and enlarges our circle of compassion. A beautiful, bewildering photograph is a wonderful place to start making sense of the staggering complexity around us. □

This essay is drawn from **Anand Varma's** 368-page coffee-table book, *Invisible Wonders: Photographs of the Hidden World*. It's available wherever books are sold.

Where Science and Photography Join Forces

After *National Geographic* published my photos of honeybees in May 2015, a scientist told me I had captured undescribed bee behavior. In pursuit of unique images, I had stumbled onto an original observation. That's when I realized that science and photography aren't mutually exclusive efforts. Science gives us structured systems for observing the world, while photography gives us tools for extending our visual perception.

To harness the combined power of both, I've launched an enterprise called WonderLab, in Berkeley, California. It draws on my training as a biologist, my experience as a photographer, my fondness for tinkering, and my desire to share what I've learned. It's a science lab, a photography studio, a makerspace, a classroom. Ideally, WonderLab will inspire new ways of visualizing science—much as an exceptional photograph gives us a fresh look at our world. To learn more, visit natgeo.org/wonderlab. —AV





Photographs can play with perceptions of time, as in this image of traffic lights shot with a long exposure on a foggy night near Weimar, Germany. The close-ups below reveal the individual bristles of a Venus flytrap and feathers of a male northern cardinal.



PHOTOS: LUCAS ZIMMERMANN (TOP); HELENE SCHMITZ (LEFT); TIM FLACH (RIGHT)

DECEMBER 2023 21

ARTICLE



Canary Islands: Eight paradises, and the legend of a ninth

Each of the Canaries is a world unto itself, with its own distinct landscape, wildlife, and culture. And there are even whispers of one more undiscovered island...

Of the eight inhabited Canary Islands, each has its own discrete natural history. All have belonged to Spain for more than half a millennium now, and the weather is consistently warm, mild, and clement across the whole archipelago.

One particular story has been told for as long as anyone can remember: The legend of a ninth. Often drawn onto past maps and charts, the spectral isle of San Borondón was named after the mystic Irish monk known as Saint Brendan the Navigator. Spreading Christianity across the seas in the 6th century, he was guided by a giant fish to a kind of heaven on Earth at the far end of this archipelago. Happening upon any of the Canary Islands today, a modern voyager will encounter an earthly paradise of incredible variety.

Ringed by yellow and black sand beaches, Tenerife is also quietly spectacular through inland forests and farmlands, ascending to the snowy, starry summit of Mount Teide. This mightiest volcano of the whole archipelago casts a long shadow over the sea, which is one possible source of the San Borondón legend.

Lively with commerce, music, and a flourishing gastronomic culture, Gran Canaria arrays some of its deepest natural pleasures across the hidden reaches of a dynamic topography. Volcanic crags, abyssal caves, towering dunes, ancient pines, and rolling green hills create a “miniature continent” unto itself.

Lanzarote’s UNESCO-protected biosphere pushes most human activity right to the margins at busy ports and lively coastal resorts. The beautifully eerie interior now draws ever-more hikers and cyclists to otherworldly massifs, plains, volcanic cones, and tunnels.

Fuerteventura has been shaped over eons by strong breezes that have whipped up sand dunes into soft looming peaks. Conditions are optimal for surfing and other watersports off golden beaches, while backroads wind their way to hidden coves and conservation areas for birdlife or sea turtles.

ARTICLE

PAID CONTENT FOR SPAIN TOURISM BOARD



Left hand page: Gran Canaria is a traveler's paradise of golden beaches, but its interior conceals a treasure trove of natural wonders. **Top right:** Celebrated with painted costumes and devilish masks, the diabletes (little devils) carnival has been held on Lanzarote for several hundred years. **Bottom right:** Lanzarote's Timanfaya National Park is a Lunar-like landscape of lava fields, smoking craters, and peaks formed by volcanic eruptions hundreds of years ago. *Map by: Guillermo Trapiello.*

Lively with commerce, music, and a flourishing gastronomic culture, Gran Canaria arrays some of its deepest natural pleasures across the hidden reaches of a dynamic topography.



On La Palma, wood-fronted houses rise out of the harbor on a wave of solid lava, while Latin-style carnivals and hand-rolled cigars attest to a long history as shipping hub between old and new worlds.

Once the island at the edge of the known world, El Hierro's many cliffs drop away abruptly into deep

waters now known for prime dive spots. A certain primeval atmosphere abides in volcanic pools and thick laurel forests, especially where local legends tell of witches gathering for ritual dances.

Among the smallest, wildest, least-visited Canaries, La Gomera rises from beaches and palm groves to misty cloud forest. Unpopulated as it is, the island still bears living witness to its distant pre-Christian past by way of the native "whistling language", Silbo Gomero.

La Graciosa is one of Europe's last outposts without asphalt roads. A few whitewashed houses and summer residences are scattered between deep blue undersea caves and terracotta-colored volcanic ranges, where native bird, fish, and lizard species far outnumber humans.

Discover your paradise:



This is paid content. This content does not necessarily reflect the views of National Geographic or its editorial staff.

ARTICLE

DISPATCHES
FROM THE FRONT LINES
OF SCIENCE
AND INNOVATION

The perfect revenge

To dissuade birds from fouling buildings, owners sometimes line ledges with strips of steel spikes. But clever Eurasian magpies rip the spikes from structures and use them to top their nests, possibly as protection against crows, a new study finds. —JASON BITTEL



ANIMAL BEHAVIOR

NEW ANGLE ON MANNERS

WHEN THE GOING GETS TIGHT, THESE FISH HAVE AN UNUSUAL ABILITY TO SLOW DOWN AND QUEUE.

A species of tiny freshwater fish found in the Amazon Basin and in home aquariums around the world was discovered to possess something that a surprising number of people appear to lack: the ability to wait their turn. In a new study published in *Scientific Reports*, researchers ushered schools of neon tetras (*Paracheirodon innesi*) through a narrow opening in their tank and found that the fish used queuing to navigate the close quarters without clogging up and impeding passage. The “courteous” creatures, which are only about an inch long, did not collide into one another as they swam near the opening. While the dexterity to exit without bottlenecking has been observed in ants, no other animal was known to have the skill. The study’s authors believe that the neon tetras’ seemingly polite behavior might have evolved to help them pass between rocks in their river habitat. These findings, the authors say, could be used to improve traffic-control strategies for autonomous cars—and perhaps for crowds of people too. —ANNIE ROTH

ARCHAEOLOGY

Pizza in Pompeii? Sort of

Several months ago, when archaeologists in Pompeii revealed a 2,000-year-old fresco showing what they believe to be a flat piece of focaccia with toppings, it wasn’t quite the pizza we know and love. While the proto-pizza might have had garnishes, tomatoes didn’t exist yet in Europe. Pompeians did use *garum*, a salty fish sauce, as “ancient ketchup” and dined on stuffed dormouse as a delicacy. —CHRISTINA STERBENZ



PHOTOS (FROM TOP): AUKE FLORIAN HIEMSTRA; BLICKWINKEL/ALAMY STOCK PHOTO; ABACA PRESS/ALAMY STOCK PHOTO

3 ARTICLES



Transforming Parkinson's Research

A 2023 breakthrough is changing what's possible in Parkinson's research. We've never been closer to finding the cure.

Learn more.

michaeljfox.org



RISKY RETAIL

THE CANDY WE EAT, the tea we drink, the lotion we use—they all likely contain ingredients from wild plants. While natural ingredients can be beneficial to buyers, the way those plants are harvested could harm ecosystems and workers. In a recent United Nations–affiliated report, medicinal plant experts revealed the risks behind several of them, including Brazil nuts, frankincense, goldenseal, gum arabic, and licorice.

Plant derivatives in household products “sit there somewhere in the middle of the ingredients list” on product labels, often going unnoticed, says Caitlin Schindler, lead author of the report. Even if consumers do take note, there’s no information about what’s involved in obtaining or processing the derivatives.

Many of these plants are threatened with extinction from overharvesting, disease and invasive pests, climate change, and habitat loss. In addition, collecting them may involve child labor, violations of workers’ rights, and even modern slavery, according to the report. Workers are often poor, female, and from marginalized rural areas. The endangered status of more than 20,000 medicinal or aromatic plant species has never been assessed, which means it’s impossible to know whether their use is sustainable.

Meanwhile, the trade in wild plants—for aromatherapy, natural medicine,

Brazil nut *Bertholletia excelsa*



Harvesters trek deep into Amazon forests to collect these nuts, which grow on tall trees. Once the shell is removed, they’re eaten whole as snacks or made into an ingredient for skin-care products.

Frankincense *Boswellia sacra*



This aromatic resin leaks from cuts made in African *Boswellia* trees. After the sap hardens, it’s scraped off and processed for use in perfumes, lotions, incense, and cosmetics; it can also treat inflammation.



Fragrance



Medicine



Cosmetic



Food

Wild plants go into many everyday products, often with human and ecological costs, but consumers can help.

BY RACHEL FOBAR

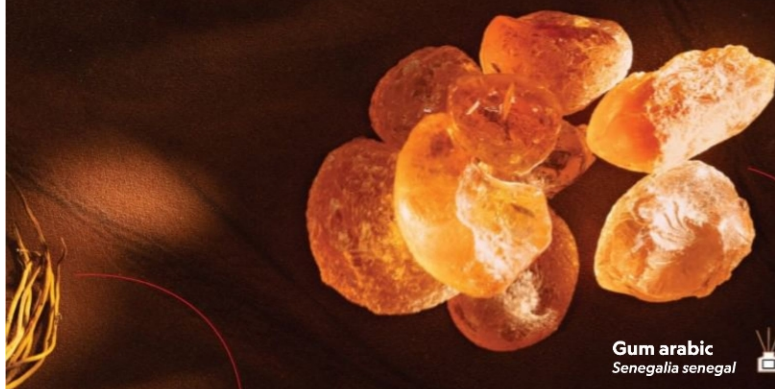


Licorice

Glycyrrhiza glabra



Often gathered by hand in rural areas of Uzbekistan and Azerbaijan, the root of the licorice herb flavors tobacco, candy, and beverages. It's also used in skin-care products and essential oils and as a supplement.



Goldenseal

Hydrastis canadensis



This slow-growing, vulnerable plant native to North America goes into medicines that help infected mucous membranes, such as those of the mouth and respiratory tract.

Gum arabic

Senegalia senegal



The sap of this African shrub is a stabilizing or thickening agent in edible items, including icing, soda, and marshmallows. It's added to essential oils and has antibacterial and anti-inflammatory properties.

PHOTO: REBECCA HALE, NGM STAFF. SOURCES: CAITLIN SCHINDLER AND OTHERS, "WILDCHECK: ASSESSING RISKS AND OPPORTUNITIES OF TRADE IN WILD PLANT INGREDIENTS," 2022, UN FOOD AND AGRICULTURE ORGANIZATION; SUSTAINABLE HERBS PROGRAM, AMERICAN BOTANICAL COUNCIL

ARTICLE

food supplements, and natural beauty products—is booming. U.S. consumers spent more than \$12.3 billion on herbal dietary supplements in 2021—up more than 9 percent from 2020. Plants such as licorice can be found in herbal preventives and remedies for COVID-19, and bark from the soapbark tree, endemic to Chile, is in the Novavax COVID-19 vaccine.

Wild plants have been used locally for centuries—frankincense in the Horn of Africa, Brazil nuts in South America, baobab powder in southern Africa—but today's global demand puts many at risk. And international customers often have no idea where these products originate.

Should consumers stop buying the products? No, Schindler says, because “the ingredients are really critical to a lot of people's livelihoods.” Solutions for transforming the trade in wild plants are rooted in awareness. The first step for consumers is to “just notice that you're buying something that has a wild ingredient,” she says. It's generally safer to purchase local products and splurge on more expensive ones, if possible.

Consumers can also look for organic and fair-trade certifications. Various programs evaluate wild-plant supply chains for sustainability and employment conditions, and many companies advertise these certifications, either on the product or online. One of the most prominent is FairWild, which assesses both human and environmental

risks and recommends best sourcing practices. Other programs include the Forest Stewardship Council, the Rainforest Alliance, Fair for Life, and the Union for Ethical Biobased Trade. If certifications are missing, Schindler encourages people to challenge companies to do better. “Until businesses get a bit more pressure from consumers, we won't see any changes happening,” she says.

“Historically, the medicinal plant industry has had a lot of secrecy in it,” says Ann Armbricht, director of the Sustainable Herbs Program, which supports transparency in herb sourcing. She says that when she got her start in this field, “there was so much discussion about where food came from, and nobody was asking where the chamomile in their [tea] came from.” Companies don't want to share proprietary information, and consumers don't think to ask.

By using contact information on company websites, consumers can pose questions: Do you source organic and fair-trade ingredients? Do you or your suppliers make site visits to the communities where your products are grown? What are you doing to combat climate change?

Companies that don't make the effort to learn about the sources of their ingredients, Armbricht says, will start doing so if consumers demand it. □

Rachel Fobar is a reporter for Wildlife Watch, our investigative reporting project focused on wildlife crime and exploitation. It's supported by the National Geographic Society.

RANGES OF CONCERN

In recent years the global trade in wild plants has skyrocketed. As species are exploited, dangers to biodiversity and local workers have also risen.

Environmental

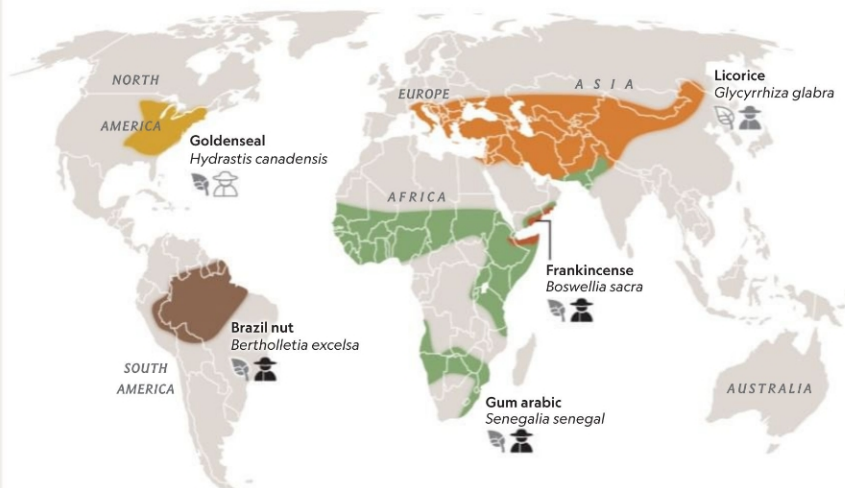
Overharvesting of the plants—along with climate change, habitat loss, and disease—can lead to species extinction.

Risk level

- High
- Medium
- Low

Human

Laborers collecting the plants can face a range of difficulties, including environmental hazards, human rights abuses, and poor pay.



LUCAS PETRIN, NGM STAFF. SOURCES: WILDCHECK 2020, UN FOOD AND AGRICULTURE ORGANIZATION; ROYAL BOTANICAL GARDENS, KEW

HIS FUTURE CAN BE **YOUR LEGACY**

When you leave a gift to the **National Geographic Society** in your will, trust, or by beneficiary designation, you can protect critical animal species for generations to come. We believe everyone deserve access to estate planning tools. That's why we are offering a free resource to our supporters.

Get started today! natgeo.org/givingdocs



CREATE A LEGACY OF YOUR OWN

☐ Yes! Please send me information on leaving a gift to the National Geographic Society.

☐ The National Geographic Society has already been included in my estate plans.

☐ I would like to speak to someone about making a gift. Please contact me.

Mail to: National Geographic Society
Planned Giving Office
1145 17th Street NW
Washington, DC 20036-4688

Contact: legacy@ngs.org
(800) 226-4438
natgeo.org/legacy

NAME

ADDRESS

PHONE

EMAIL

The National Geographic Society is a 501(c)(3) non-profit organization. Our federal tax ID number is 53-0193519.



23PGAD12

CIRCLING THE GLOBE IN SEARCH OF THE PAST

ALBERT LIN IS A RARE KIND OF ENGINEER—one who scales cliffs, battles rivers, and rappels into caverns. The National Geographic Explorer is on a quest to uncover the hidden remnants of former civilizations for his new show, *Lost Cities Revealed With Albert Lin*. He not only uses data, drones, modeling software, and aerial imaging to locate relics, but he also hikes into forests, deserts, and jungles, with the help of a titanium prosthesis in place of his right leg, which he lost after a vehicle accident.

The journeys take him to the mountains of Peru to find the Cloud Warrior people conquered by the Inca and to Oman to explore Magan, a Bronze Age land. He visits ancient pyramids in Sudan and a former settlement of Scottish tribespeople, whose members fought off the Roman army. "There's still so much to be learned about who we are and where we come from," Lin says. The series is filled with twists, often from unexpected acts of nature, such as a tense rafting accident, and harrowing suspense, like a night camping beside one of the world's deadliest scorpions. While Lin was looking for the biblical Canaanites in Israel, a falling boulder shattered his prosthetic leg. Luckily, he had a spare. —DANIEL STONE

Albert Lin perches on a cliff edge while seeking traces of the Cloud Warrior people in Peru.



Catch season one of *Lost Cities Revealed With Albert Lin* on National Geographic starting November 23 and Disney+ November 29.



PHOTO: ROCÍO LIRA SALAS, NATIONAL GEOGRAPHIC FOR DISNEY

ARTICLE



FOR ONE AMAZING LIFE

DAY 1

PROVEN NATURAL NUTRITION

DAY 24

STRONG IMMUNE SYSTEM

DAY 28

**STRONG MUSCLES INCLUDING
A HEALTHY HEART**

Purina trademarks are owned by Société des Produits Nestlé S.A.

**A Difference
From Day ONE™**



Your Pet, Our Passion®

WHAT'S
NEW AND
NOTEWORTHY
AROUND
THE WORLD

From luminous
craftsmanship
in Britain to
conservation in
Cameroon.

BY RONAN O'CONNELL



1

RARE WINDOWS

The Endangered Art of Stained Glass

For 900 years this style of window has bathed British castles and cathedrals (such as Liverpool's, below) in colorful, dappled light. But a recent report reveals that fewer than 60 stained-glass makers remain in the United Kingdom, primarily because of rising material costs and fewer study pathways for prospective artisans. A new youth-recruitment drive aims to secure lasting production of these precious panes.



2

AFRICAN
PARK

CAMEROON'S KORUP RAINFOREST RECENTLY BECAME A UNESCO BIOSPHERE RESERVE. THE MANA RIVER FOOTBRIDGE LEADS INTO THE PARK, HOME TO UNIQUE FLORA AND THE CRITICALLY ENDANGERED CROSS RIVER GORILLA.

UP IN
THE AIR

A TRAINED mechanical engineer, Alexander Calder pioneered the mobile, a sculpture that moves via motors or air currents. His 1948 "Dispersed Objects With Brass Gong" (above) is in a collection of 62 works by the late American artist displayed together for the first time at the Seattle Art Museum, in Washington. "Calder: In Motion, the Shirley Family Collection" will be part of a multiyear project exhibiting the innovator's mobiles, stabiles, wire sculptures, and oil paintings. His 39-foot-tall, bright red, steel "Eagle" already roosts permanently in Seattle's waterfront Olympic Sculpture Park.

4

IMPERIAL VIEWS

Towering walls ring Hue's Imperial City, the hub of Vietnam's Nguyen dynasty (1802-1945). A new walkway allows tourists to view the citadel from atop a part of those fortifications, including the majestic temple The To Mieu and its entrance gate (right) protected by statues of dragons, unicorns, phoenixes, and turtles.



PHOTOS: ALBERTO MANUEL UROSA TOLEDANO, GETTY IMAGES (WINDOW); CAGAN HAKKI SEKERCIOGLU, GETTY IMAGES (RIVER); © 2023 CALDER FOUNDATION, NEW YORK/ARTISTS RIGHTS SOCIETY (ARS), NEW YORK (MOBILE); TRIP NUTS AND BOLTS/ALAMY STOCK PHOTO (TEMPLE)

ARTICLE

WINES OF THE WORLD

HOLIDAY CHEERS

Discover 6 superb sustainable wines

JUST \$69.99 + FREE shipping

Give the gift of wine exploration this festive season— with 6 thrilling wines from passionate producers in exciting regions who are doing things the right way.

There's gold-medal Cabernet, a **gold-medal** Italian rarity, a **90-point** Spanish blockbuster and more. This isn't a wine club offer, but an invitation to taste the **sustainable wines** we're most excited about and get a head start on your holiday shopping.

SAVE 40%
+ 4 FREE Gift Bags

Sustainable Growing • Recycled Glass • Low Carbon Footprint • Organic • Paper Bottle

YOUR PURCHASE HAS PURPOSE

ORDER NOW AT natgeowine.com/save40

OR CALL 1-844-485-1027 Quote Code AFHQ001

Brought to you by

LAITHWAITES

100% money-back guarantee applies to all wines. Offer subject to availability. All orders fulfilled by licensed retailers/wineries and applicable taxes are paid. You must be at least 21 years old to order. Offer valid in U.S. only excluding AL, AR, CO, DE, GA, HI, ID, KS, KY, MD, ME, MS, MT, OK, PA, RI, SD, TN, UT, VT. See full terms and conditions online. Void where prohibited by law. © 2023 National Geographic Partners LLC. All rights reserved. NATIONAL GEOGRAPHIC and Yellow Border Design are trademarks of the National Geographic Society, used under license.

STATEMENT OF OWNERSHIP, MANAGEMENT, AND MONTHLY CIRCULATION

NATIONAL
GEOGRAPHIC

OWNER AND PUBLISHER: National Geographic Partners, LLC
DAVID E. MILLER, EVP & GM
NATHAN LUMP, EDITOR IN CHIEF

HEADQUARTERS OF PUBLISHER AND PUBLICATION: 1145 Seventeenth Street N.W., Washington, DC 20036

STOCKHOLDERS; BONDHOLDERS; MORTGAGE; OTHER SECURITY HOLDERS: National Geographic Society and The Walt Disney Company

	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MOS.	SINGLE ISSUE NEAREST TO FILING DATE
A. TOTAL COPIES PRINTED (Net Press Run)	OCT 2022 - SEPT 2023 1,636,921	SEPTEMBER 2023 1,510,769
B. PAID CIRCULATION		
1. Outside-County Mail Subscriptions	1,191,465	1,090,834
2. In-County Mail Subscriptions	-	-
3. Single Copy Sales/Non-USPS Paid Distribution	288,855	271,327
4. Other Classes Mailed Through USPS	-	-
C. TOTAL PAID CIRCULATION	1,480,320	1,362,161
D. FREE DISTRIBUTION (includes samples, no news agents)		
1. Outside-County	27,701	29,587
2. In-County	-	-
3. Other Classes Mailed Through USPS	-	-
4. Free Distribution Outside the Mail	1,330	1,332
E. TOTAL FREE DISTRIBUTION	29,031	30,919
F. TOTAL DISTRIBUTION (Sum of C and E)	1,509,351	1,393,080
G. OFFICE USE, LEFTOVER, ETC.	127,570	117,689
H. TOTAL (Sum of F and G)	1,636,921	1,510,769
I. PERCENT PAID	98.1%	97.8%



Young rescued tigers Clay, Daniel, and Enzo rest after some vigorous play at the Wild Animal Sanctuary in Colorado.

BIG CATS GET A REPRIEVE

A GRUELING FORAY INTO THE UNDERBELLY OF AMERICA'S CAPTIVE-TIGER INDUSTRY ENDS WITH A RAY OF HOPE.

BY STEVE WINTER, WITH SHARON GUYNUP

OUR TWO-YEAR INVESTIGATION into captive tigers in America sent us through 32 U.S. states—with some truly disturbing experiences. But as the deadline for our *National Geographic* story loomed, I still needed a powerful, hopeful image.

When we began our reporting in 2017—Sharon, writing; me photographing; and our son, Nick Ruggia, filming—more tigers likely lived in cages in the U.S. than remained in the wild. Estimates ranged from 5,000 to 10,000, but with lax government oversight, no one knew for sure. There was no federal law regulating big-cat ownership.

Roadside zoos that allowed tourists to cuddle and shoot selfies with cubs were at the root of what's been

called a U.S. tiger crisis. Captive-bred cats often ended up in the illegal wildlife trade. To maintain a constant supply of babies, tigresses were forced to churn out litter after litter. Cubs, wrenched from their mothers at birth, were fed poorly and handled by hundreds of people. When they grew too big and dangerous to pet at around 12 weeks, cubs became breeders, were put on display, or simply disappeared. Many of these venues passed themselves off as sanctuaries. At least one made a million dollars or more in annual revenue.

Zigzagging the country, we interviewed hundreds of people for the story, including owners, workers, and customers at both roadside zoos and true sanctuaries, as well as wildlife biologists, conservationists,

PHOTO: STEVE WINTER

ARTICLE

FISHER INVESTMENTS®

READY, SET, RETIRE!

Review your retirement plan now to make sure you're on track for a comfortable retirement

Get three of Fisher Investments' best retirement guides collected in the **Ready, Set, Retire Kit**—at no cost! Investors with \$500,000+, call **888-353-2010** or visit **FisherRetirePlan.com/Tips** to request your kit today.

The guides in the **Ready, Set, Retire Kit** can help you make the most of your retirement.

- Get ready to create or review your retirement plan with **The 15-Minute Retirement Plan**.
- Set up income streams from your portfolio using **The Definitive Guide to Retirement Income**.
- Retire comfortably with great ideas from our most successful clients in **99 Retirement Tips**.

This exclusive retirement planning kit is only available for a limited time.



To request your kit today, call
888-353-2010,
visit **FisherRetirePlan.com/Tips**
or scan the QR code.



SCAN HERE
to Get Your Guides



Judith Abrams
Regional Sr. Vice President

No cost and no obligation beyond completing a short request form and brief survey. Investments in securities involve the risk of loss. ©2023 Fisher Investments. 6500 International Pkwy., Ste. 2050, Plano, Texas 75093.

prosecutors, and U.S. Fish and Wildlife Service agents. Sometimes we went undercover, sometimes not.

We filmed and photographed cub petting at run-down zoos, a high-end safari show, an Illinois county fair, and an Oklahoma living room. We saw sick, skeletal tigers—some scarred, cross-eyed, or disabled—living in squalid quarters. We discovered illicit activities, including animal abuse, donations used for personal profit, and wildlife trafficking, which drives poaching of the last wild tigers.

Sharon corresponded with Joe Exotic, the infamous “Tiger King” who’s now serving a 21-year sentence for murder for hire and falsifying criminal records, as well as killing and trafficking tigers at his former G.W. Exotic Animal Park in Oklahoma. I spent nine days photographing Bhagavan “Doc” Antle and his Myrtle Beach Safari attraction. In June 2023 Antle was convicted of felony wildlife trafficking and conspiring to traffic in wildlife.

While we documented the underbelly of this industry, we also wanted to show the best life these magnificent apex predators—unable to be released into the wild—could have in captivity. With two weeks left before my deadline, I headed to the Wild Animal Sanctuary near Denver, where well-nurtured cats roam acres of habitat.

There I met Clay, Daniel, and Enzo, three of 39 tigers



AWARD WINNERS

The prestigious annual Eliza Scidmore Award for Outstanding Storytelling is presented by the National Geographic Society.

The award is named for the writer and photographer who, in 1892, became the first woman elected to the Society’s board. In 2024 the award will recognize National Geographic Explorers Steve Winter and Sharon Guynup for their compelling investigative reporting on the plight of captive tigers in the U.S.

rescued from Joe Exotic’s former zoo. These huge, nearly grown cats frolicked, racing beside our ATV as we drove the fence line and sparring on their hind legs—behavior I’d seen only in wild tigers.

It was a steamy July day, and soon two of the cats jumped into a stock tank to cool off. The third settled beside them on the ground. I crossed the road to shoot pictures of another tiger, framed by a patchwork of blue sky and gray clouds, with the last rays from the sun streaming through as it dipped behind the Rocky Mountains.

Then I heard my assistant loud-whisper, “Steve, you said you wanted a rainbow. You got one!” I crawled

back toward the trio, trying not to disturb them, and slipped my lens through the fence. The third cat laid its head against the tank, and I had the shot: three contented tigers, framed by a rainbow.

When the story ran in 2019, members of Congress who’d sponsored legislation regulating big cats received a copy. Three years later, the Big Cat Public Safety Act became law, prohibiting private ownership in most circumstances and public hands-on contact. The U.S. cub-petting industry is now a thing of the past. □

Steve Winter photographed and **Sharon Guynup** wrote “The Tigers Next Door,” which ran in the December 2019 issue of the magazine.



Writer Sharon Guynup captures photographer Steve Winter in action with a selfie taken atop Elephant Rock during recent fieldwork in Sri Lanka. The team works together to document the challenges facing big cats and other animals.

PHOTO: SHARON GUYNUP

NATIONAL GEOGRAPHIC

DECEMBER 2023

Pictures of the Year..... P. 36

Alhambra's Legacy..... P. 88

Dwindling Caribou..... P. 112

FEATURES



112

CARIBOU ARE CREATURES OF HABIT, AND THEIR HABITS SEEM SYNCED TO AN OLDER AND COLDER WORLD. THE QUESTION IN OUR TIME IS HOW QUICKLY THEY WILL OR WON'T ADAPT.

PHOTO: KATIE ORLINSKY

ARTICLE



ARTICLE



ARCTIC ELEGY

WHITE SEA, RUSSIA

Marine biologist Alexander Semenov calls the lion's mane jellyfish the queen of the Arctic seas. He photographed this regal specimen in its final stage of life: Having reproduced, it has shrunk in size, digested or shed its hundreds of long tentacles, and become, in Semenov's words, an "alien flower."

• PHOTOGRAPH BY
ALEXANDER SEMENOV



REACHING FOR THE MOON

COCONINO COUNTY, ARIZONA

Before the Artemis program sends humans to the lunar surface, NASA performs high-fidelity tests on Earth.

For a mock moonwalk, astronaut Zena Cardman wore this training suit weighing more than 80 pounds to simulate a real suit's range of motion and weight in lunar gravity.

• PHOTOGRAPH BY
DAN WINTERS

ARTICLE

NATIONAL GEOGRAPHIC

P- I- C- T- U- R- E- S P H E R E

▶ NATIONAL GEOGRAPHIC PHOTOGRAPHERS TRAVEL THE GLOBE TO
CAPTURE THE WONDER OF OUR WORLD AND THE SPIRIT OF OUR TIMES.
HERE WE PRESENT OUR ANNUAL SELECTION OF THEIR BEST WORK.



DECEMBER
2023

Y E A R T H

PAGE
39



ARTICLE



NATIONAL GEOGRAPHIC

SNOW PATROL

SODANKYLÄ, FINLAND

At a military facility north of the Arctic Circle, Finnish and U.S. soldiers train for winter warfare by navigating an obstacle course while on skis. The exercise took place two months before Finland—which shares an 800-mile border with Russia—joined NATO. The training was arranged in response to the war in Ukraine.

PHOTOGRAPH BY
LOUIE PALU

41

ARTICLE



NATIONAL GEOGRAPHIC

SPIRITS OF THE AMAZON

PUERTO NARIÑO,
COLOMBIA

In the cosmology of the Tikuna, one of the largest Indigenous groups in the Amazon, pink dolphins are mischievous spirits and guardians of the watery realm. Women dance in dolphin costumes made from the bark of the *yanchama* tree.

•
PHOTOGRAPH BY
THOMAS PESCHAK

PESCHAK'S TWO-YEAR EXPEDITION ACROSS THE AMAZON IS SUPPORTED BY ROLEX'S PERPETUAL PLANET INITIATIVE, A PARTNERSHIP WITH NATIONAL GEOGRAPHIC SOCIETY.

ARTICLE



ARTICLE

SPOTTED UP CLOSE

MASAI MARA
NATIONAL RESERVE,
KENYA

Soon after dawn at Lemek Conservancy, spotted hyenas arrive at a pond to drink. Widely misunderstood, hyenas are fierce, intelligent, and social, living and hunting as members of matriarchal clans. Jen Guyton captured this close-up with an armored, remote-controlled robot designed by National Geographic photo engineers.

•
PHOTOGRAPH BY
JEN GUYTON



ARTICLE

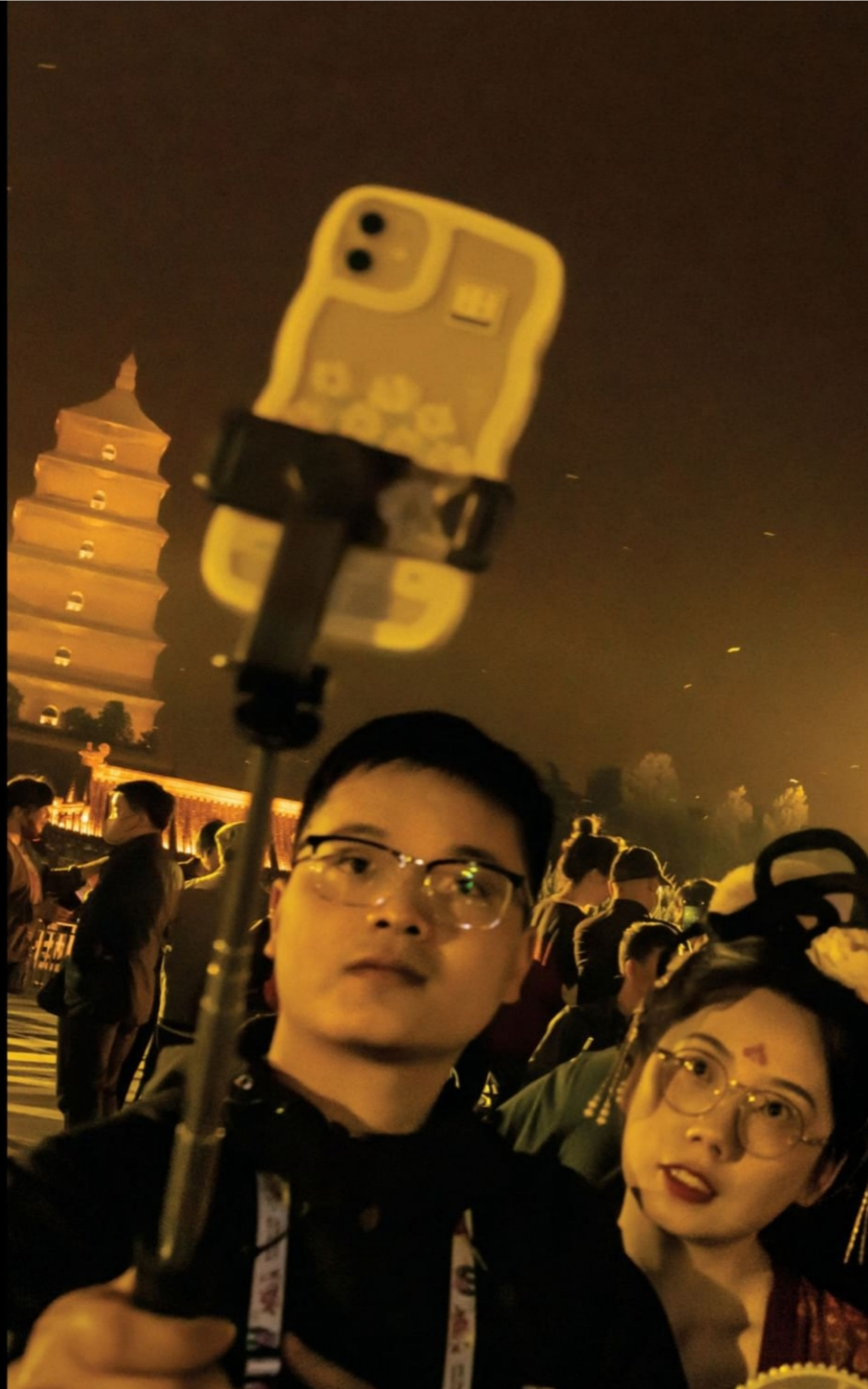


ARTICLE



NATIONAL GEOGRAPHIC

46



ARTICLE

BUDDHISM TOURISM

XI'AN, CHINA

On Chinese Labor Day, tourists pose for a selfie in front of a pagoda and bronze statue of Xuanzang, the seventh-century Buddhist monk who spent 16 years on a pilgrimage to India and translated dozens of manuscripts from Sanskrit into Chinese.

•

PHOTOGRAPH BY
JOHN STANMEYER



ARTICLE



LOOKING GLASS

CHIBA, JAPAN

Workers at the Chiba Kogaku glass factory use sledgehammers to remove the clay pot around a core of optical glass. Highly resistant to air-temperature changes, the glass will be cut into slabs, shipped to the University of Arizona's observatory, then melted and cast into mirrors for large, high-altitude telescopes.

PHOTOGRAPH BY
CHRISTOPHER PAYNE



ARTICLE



ARTICLE



LIFE IN UNLIKELY PLACES

FRASASSI CAVES,
ITALY

Caver Valentina Mariani (above), National Geographic Explorer Kenny Broad (center), and Nadir Quarta prepare for a dive into the dark, toxic waters of Lago Verde. Such sunlight-starved ecosystems could offer a glimpse into the chemistry of life in alien seas.

•
PHOTOGRAPH BY
CARSTEN PETER



NATIONAL GEOGRAPHIC



NATIONAL GEOGRAPHIC

FEAST FOR THE EYES

JARQORGON,
UZBEKISTAN

An all-woman ceremony beneath a hand-embroidered *suzani* marks a son's departure to study in the capital, Tashkent. While one recites Quranic verses, others remove a covering to bless the flatbread. This ritual was influenced by Zoroastrianism, one of the world's oldest living religions.

•
PHOTOGRAPH BY
MATTHIEU PALEY



ARTICLE



ARTICLE



NATIONAL GEOGRAPHIC

54



ARTICLE



RAISE AND RELEASE

CHICAGO, ILLINOIS

A seven-foot-long zebra shark glides through an exhibit at Shedd Aquarium, one of several aquariums where endangered zebra sharks are breeding to produce eggs for shipment to Indonesia. They will be raised and released into a marine protected area in Raja Ampat to rebuild its wild population.

•
PHOTOGRAPH BY
DAVID DOUBILET

ARTICLE

I WANTED TO DOCUMENT SOMALILAND IN A WAY
THAT EMPOWERED WOMEN. BOLD. COURAGEOUS. DRIVEN.

—DIANA MARKOSIAN, PHOTOGRAPHER



GAME CHANGERS

HARGEISA,
SOMALILAND

Markosian traveled to Somaliland—an unrecognized, self-declared state within Somalia—three decades after the country emerged from civil war. She found plenty of youthful energy: “I met a generation of girls who are mixing things up and reshaping culture while also maintaining tradition.” Left: Hafsa Omar, 20, and her sister Asma, 18 (holding ball), play on a women’s basketball team and attend university. Hafsa also works digitizing cassette tapes and other media containing music, speeches, and more. Right: Suhuur Hassan, 19, and Muhim Mawliid, 20 (looking at camera), study traditional dance at Hargeisa’s Halkar Academy.

•
PHOTOGRAPHS BY
DIANA MARKOSIAN

ARTICLE



NATIONAL GEOGRAPHIC

57

ARTICLE



NATIONAL GEOGRAPHIC

58



ARTICLE



LIFE WITH GIANTS

VALPARAI, INDIA

Elephants wander a tea estate that was once part of their forest habitat before being converted to crop production in the late 1800s. Today about 70,000 people live and work in the region among 120 elephants.

•

PHOTOGRAPH BY
BRENT STIRTON

ARTICLE



NATIONAL GEOGRAPHIC

FLIGHT SCHOOL

PROVIDENCE,
RHODE ISLAND

At Brown University, doctoral student Brooke Quinn (blue glove) and her adviser, Sharon Swartz, work with a Seba's short-tailed bat inside a wind tunnel. They are testing how tiny sensory hairs on bats' wings affect their flight responses to turbulence.

•

PHOTOGRAPH BY
NICHOLE SOBECKI

60

ARTICLE



ARTICLE



NATIONAL GEOGRAPHIC

TLC FOR THE KIWI

WELLINGTON,
NEW ZEALAND

Field specialists examine a North Island brown kiwi two months after 11 of the birds were released outside New Zealand's capital. A national symbol, kiwis have been decimated by predators, especially stoats, introduced in the 1800s.

•
PHOTOGRAPH BY
ROBIN HAMMOND

62

ARTICLE

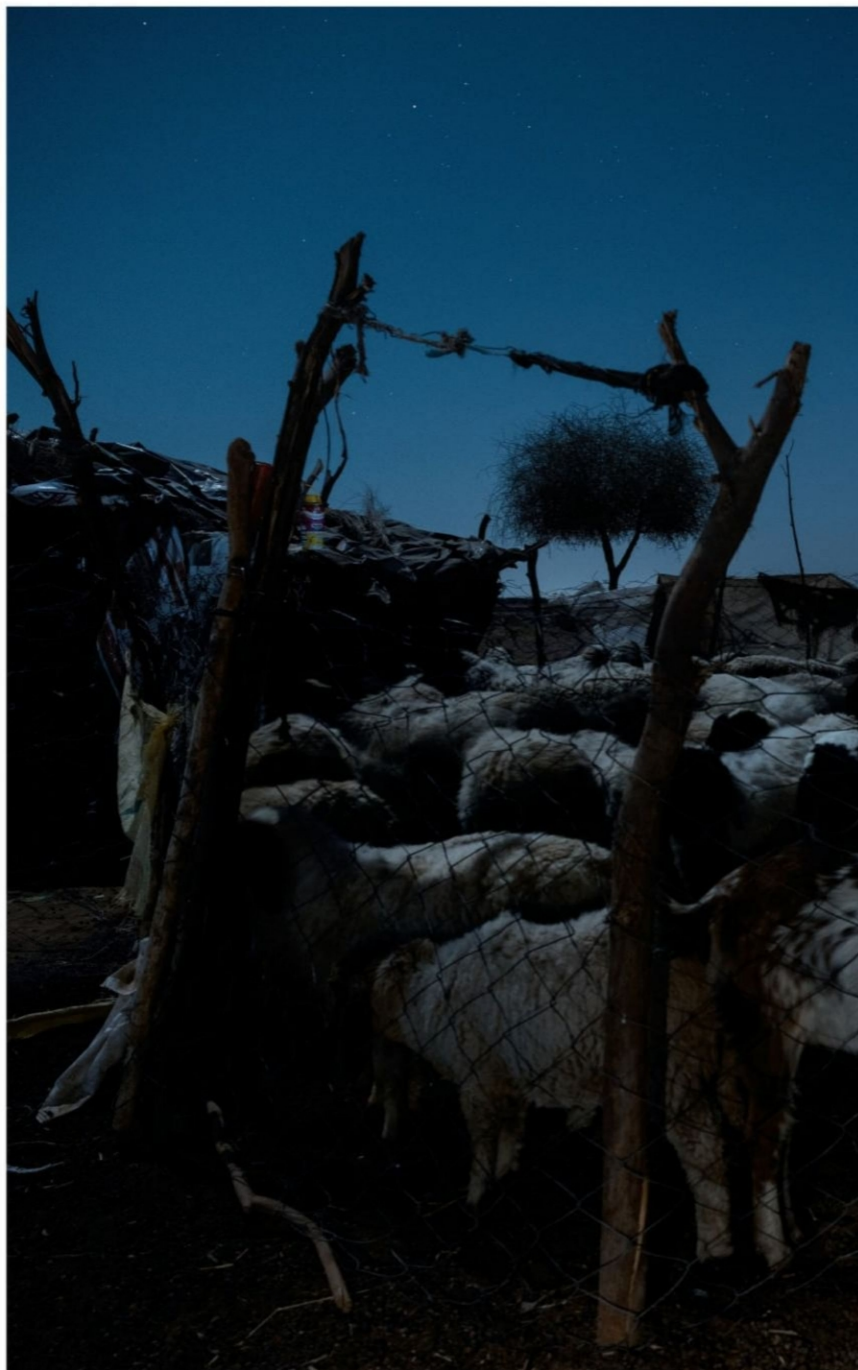


ARTICLE



NATIONAL GEOGRAPHIC

64



ARTICLE



BOMB SIGHT

CHACHA, INDIA

Taj Mohammad stands among his sheep and goats in the desert landscape of Rajasthan. As a boy in 1998, Mohammad felt the ground shake and witnessed a gigantic dust cloud when India conducted underground nuclear tests at the nearby Pokhran site. India is currently one of nine countries with nuclear weapons.

PHOTOGRAPH BY
CHINKY SHUKLA

ARTICLE

BACK TO LIFE

NEW HAVEN,
CONNECTICUT

To better study how cells from one region of the brain connect with cells in others, Yale researchers looked for a way to reanimate recently dead brain tissue. The team succeeded with a pig's brain by combining a custom drug cocktail (blue) with an oxygen carrier (dark red).

•
PHOTOGRAPH BY
MAX AGUILERA-
HELLWEG



ARTICLE



NATIONAL GEOGRAPHIC

67

ARTICLE



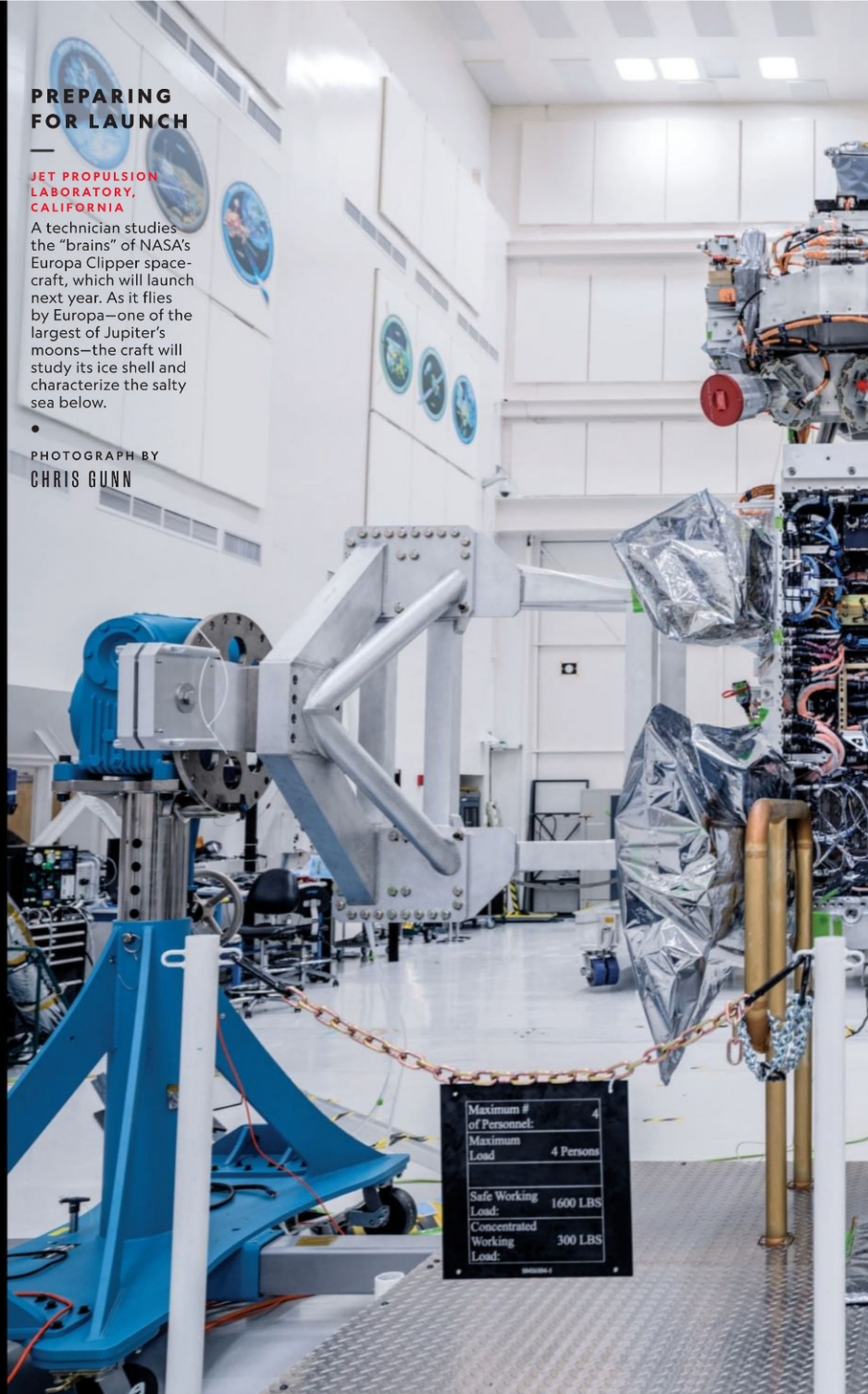
NATIONAL GEOGRAPHIC

PREPARING FOR LAUNCH

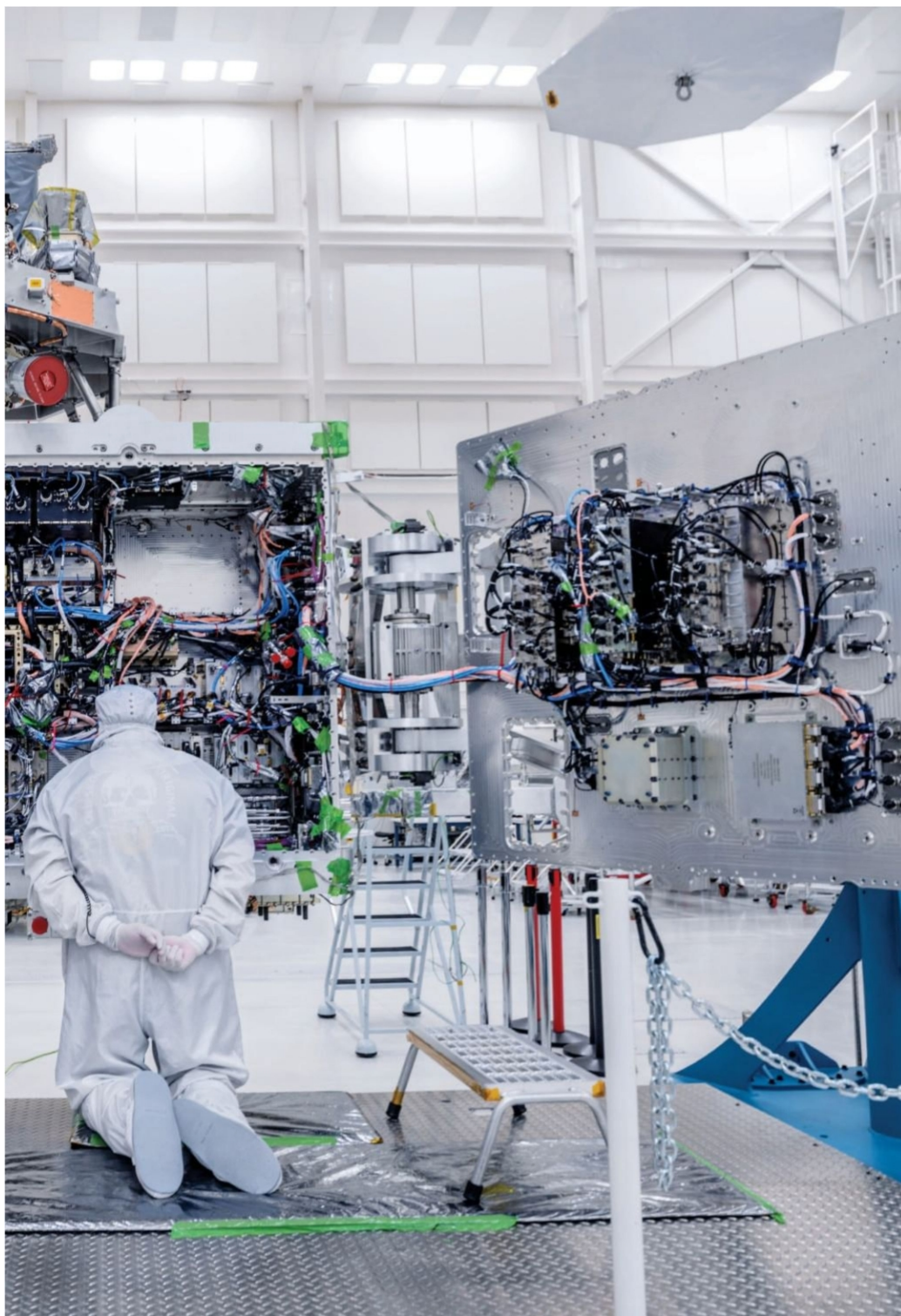
JET PROPULSION
LABORATORY,
CALIFORNIA

A technician studies the “brains” of NASA’s Europa Clipper spacecraft, which will launch next year. As it flies by Europa—one of the largest of Jupiter’s moons—the craft will study its ice shell and characterize the salty sea below.

PHOTOGRAPH BY
CHRIS GUNN



ARTICLE



ARTICLE

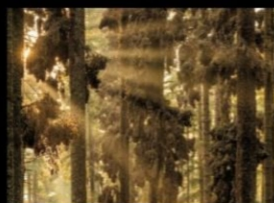
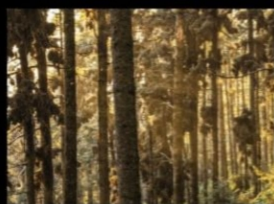
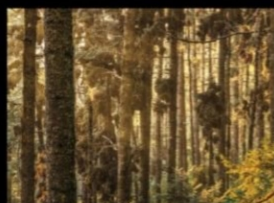
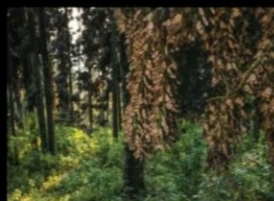
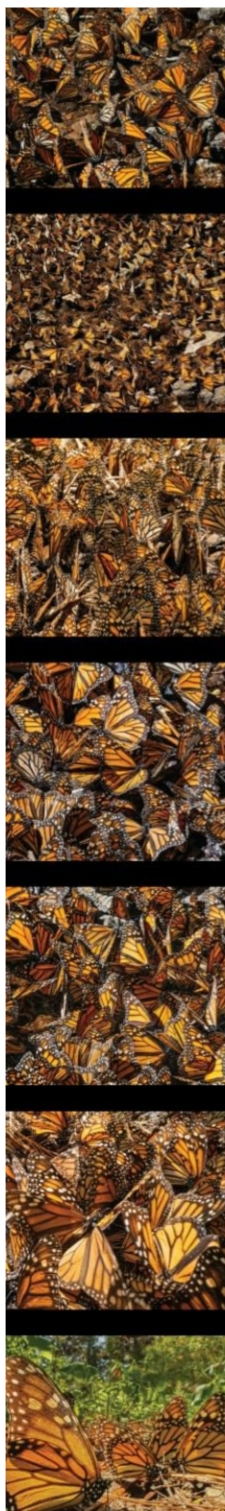


NATIONAL GEOGRAPHIC

70



ARTICLE



CONTACT SHEET

WHERE MONARCHS REIGN

MONARCH BUTTERFLY BIOSPHERE
RESERVE, MEXICO

When photo editor Anne Farrar considers images for publication, she says, “I’m looking for special. I’m looking for unique.” Farrar found that quality in spring 2023 when Jaime Rojo submitted tens of thousands of recent images of monarch butterflies, including the scenes at left. For almost 20 years, Rojo has been visiting the forested mountains in central Mexico where North America’s eastern populations of the migratory insect spend winters. The photographer is “immensely knowledgeable about this location and the butterflies themselves,” Farrar says, and that familiarity helps his pictures outshine those of tourists allowed a few minutes at the site. After reviewing every one of Rojo’s images and consulting with him, Farrar arrived at about 20 selections for a story in next month’s issue.

•
PHOTOGRAPHS BY
JAIME ROJO

ARTICLE



NATIONAL GEOGRAPHIC

72



ARTICLE



ALIGHT IN A FOREST

MONARCH BUTTERFLY
BIOSPHERE RESERVE,
MEXICO

Streaked with sunlight and crowded together for warmth in winter, monarch butterflies blanket fir trees in El Rosario Sanctuary. Rojo received special permits to work outside the sanctuary's operating hours. He made this photograph shortly before sunset.

•
PHOTOGRAPH BY
JAIME ROJO

ARTICLE



ORIGIN OF SPECIES

PUNTA ARENAS, CHILE

A Darwin's rhea, named for naturalist Charles Darwin, is displayed at the Maggiorino Borgatello museum. Darwin encountered the species of flightless bird in 1834 during a tour of Patagonia. Comparing it with the larger American rhea helped him realize that two species can arise from a common ancestor.

PHOTOGRAPH BY
MARCIO PIMENTA

ARTICLE



ARTICLE



NATIONAL GEOGRAPHIC

76



ARTICLE



GUARDING A TREASURE

HELEN REEF, PALAU

Brian Fidiy jumps from a boat into the Helen Reef lagoon to fish for food with a homemade spear-gun. Fidiy and fellow Helen Reef rangers—all members of the local Indigenous population—protect Palau's most biologically diverse reef from illegal commercial fishing.

•
PHOTOGRAPH BY
KILIII YÜYAN

ARTICLE



CARBON THAT SPARKLES

NEW YORK, NEW YORK

Climate-tech start-up Aether transforms carbon dioxide captured from the air into lab-grown diamonds such as this two-carat princess cut. Aether's

process uses clean energy sources, and the company pledges to remove an extra 20 metric tons of CO₂ for every carat of diamond it creates—more CO₂ than the average American produces in a year.

• PHOTOGRAPH BY
DAVIDE MONTELEONE



A PLACE TO BE ONESELF

LAGOS, NIGERIA

Ashley Okoli dances at a Lagos night-club, which offers a rare welcoming space for people of all sexual orientations. Same-sex

relationships are illegal in Nigeria, yet in the past four years LGBTQ activists have celebrated Pride month with performances and protests in some parts of the country.

• PHOTOGRAPH BY
YAGAZIE EMEZI

ARTICLE



NATIONAL GEOGRAPHIC

IT WAS A PRIVILEGE THAT ASHLEY ALLOWED ME TO SHARE
IN HER EXPRESSION OF QUEER JOY, SURROUNDED BY
PEOPLE UNITED IN THE FREEDOM OF DANCE AND MUSIC.

— YAGAZIE EMEZI, PHOTOGRAPHER

79

ARTICLE



WELCOME WATERS

KOLWEZI, DEMOCRATIC REPUBLIC OF THE CONGO

Pastor Ngoy Niko (right) of the African Apostolic Church of Congo presides over the baptism of a new member in the Lualaba River. The congregants use this stream for initiation and purification rituals because they believe it is one of the few still clean amid local mining for cobalt.

PHOTOGRAPH BY
DAVIDE MONTELEONE



ARTICLE



FERVOR WITH A FLOURISH

DOÑANA NATIONAL PARK, SPAIN

Pilgrims sing, dance, and play flamenco during a stop along their spring journey to the Virgin of Rocío shrine. Photographer Aitor Lara says that the group's lyrics "reflect the magical experience of the pilgrimage and the joy of being able to present their fervor to the Virgin."

PHOTOGRAPH BY
AITOR LARA





ARTICLE



BRAVING THE WAVES

SOUTH ATLANTIC OCEAN

Volcanologists and mountaineers return after a weeks-long expedition to Mount Michael, a remote volcano in the South Sandwich Islands. The team made a successful first ascent and study of the peak, which holds one of Earth's few lava lakes.

•
PHOTOGRAPH BY
RENAN OZTURK

ARTICLE



NATIONAL GEOGRAPHIC

NORTHERN LIGHT

NY-ÅLESUND, NORWAY

The Reverend Siv Limstrand of the Church of Norway is the only pastor for the Svalbard archipelago in the Arctic Ocean, welcoming worshippers of any nationality and religion. As the Arctic warms, Limstrand's congregation of scientists and local people is chronicling, and coping with, climate change.

•
PHOTOGRAPH BY
ESTHER HORVATH



ARTICLE



NATIONAL GEOGRAPHIC

87

ARTICLE



Crowning a Granada hill, the Alhambra embodies the architectural golden age of Muslim rule on the Iberian Peninsula. Its plain walls belie a refined interior. The 14th-century Comares Palace (with its tower at far left) was one of several built by a succession of sultans. A predominant palace (at right) was added later for a Christian king.

CHRISTIAN HEEB, LAIF/REDUX

ARTICLE

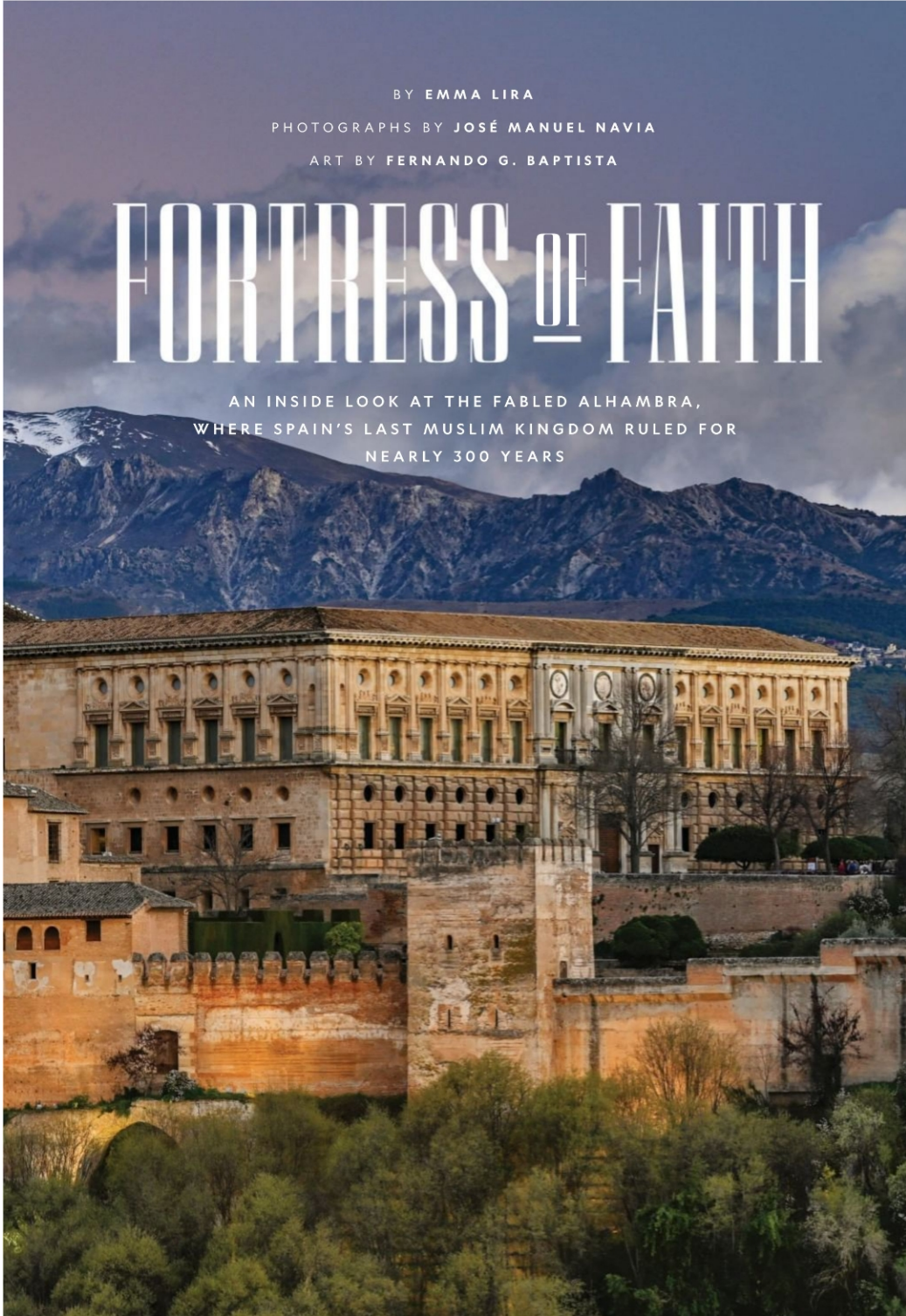
BY EMMA LIRA

PHOTOGRAPHS BY JOSÉ MANUEL NAVIA

ART BY FERNANDO G. BAPTISTA

FORTRESS OF FAITH

AN INSIDE LOOK AT THE FABLED ALHAMBRA,
WHERE SPAIN'S LAST MUSLIM KINGDOM RULED FOR
NEARLY 300 YEARS



ARTICLE



ARTICLE



Intimate spaces frame outdoor views. The defensive Tower of the Captive (left), named for a sultan's legendary

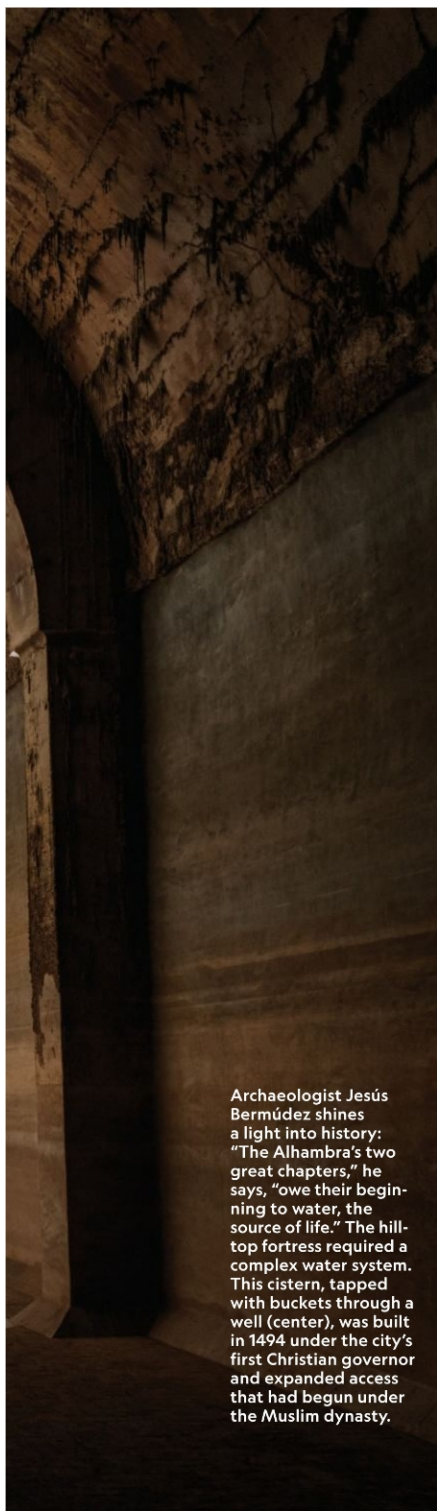
love interest held there, was converted into a small palace. Its walls are adorned with Arabic inscriptions—a

design element throughout the site—describing the tower's beauty. Christian rulers left their own imprint

when they built chambers for a king. They enclosed a garden, creating the cloister-like Lindaraja Courtyard.



ARTICLE



Archaeologist Jesús Bermúdez shines a light into history: “The Alhambra’s two great chapters,” he says, “owe their beginning to water, the source of life.” The hill-top fortress required a complex water system. This cistern, tapped with buckets through a well (center), was built in 1494 under the city’s first Christian governor and expanded access that had begun under the Muslim dynasty.

J

JESÚS BERMÚDEZ has deep ties to the Alhambra. Born in the fortress built on an imposing hill in Granada, Spain, he grew up within the palace’s walls. When his father became director of the Alhambra museum in mid-century, the family moved into a house inside the monument. It was “the stage,” as he calls it, on which his days played out, an upbringing that steeped him in its legends and history from an early age—and inspired an enduring devotion to it. For nearly four decades, Bermúdez has been the archaeologist and conservator at the Alhambra, seen as the crowning glory of the nearly 800-year Muslim reign on the Iberian Peninsula. Though he moves through the complex with the easy familiarity of navigating one’s own home, he still manages to impart a sense of wonder, as if glimpsing it for the first time. He stops often to greet student groups, guards, guides, gardeners. He displays the same pride I imagine the sultans must have had when they showed their palace to visitors.

Bermúdez is the ideal guide for a behind-the-scenes tour (and has also written the official guide). Starting from the Gate of Justice, the largest of the Alhambra’s four entry points, we explore not only its trademark courtyards and towers but also the recesses that few are allowed to see, places where fact intermingles with fable. As researchers continue to plumb its depths, the Alhambra remains a site for archaeology and restoration, including a rebirth of one of its most enigmatic works of art, recently completed after nearly 20 years.

FORTRESS OF FAITH 93

ARTICLE



In the Hall of the Kings, an enigmatic 14th-century painting—newly restored—may depict Granada's sultans or a council of judges. Illustrated in vivid pigments drawn from lapis lazuli, hematite, cinnabar, and gold, the scene's Gothic style is reminiscent of the work of artists in Italy and France.

"The Alhambra is first and foremost a palatine city," he says. "It was the seat of the head of state, with military barracks, a courtly city, and a set of palaces built over the course of two and a half centuries." The monument grew over that time from the primitive Alcazaba, or fortress, built by Muhammad I beginning in 1238, to later palaces reflecting the Nasrid dynasty's sumptuous style. A line of sultans from the Nasr family ruled until 1492, when this last stronghold of Muslim authority on the peninsula was toppled by a newly unified Spanish monarchy after the marriage of Isabella of Castile and Ferdinand of Aragon.



During the 254 years the Nasrids governed the Granada emirate, which extended far beyond the city itself, this part of today's Andalusia region was "frozen in time, maintaining a feudal society secluded in an idyllic oasis," Bermúdez explains. And yet the kingdom left a legacy in a monument considered the pinnacle of the beauty and architectural refinement born in Al Andalus, as the larger Muslim-ruled region was known. History could never forget it.

With Granada's fall, a succession of Catholic governors ran the fortress until the beginning of the 19th century, when it was occupied by Napoleon's troops. They decimated it on their

departure. The Spanish crown eventually ceded it to the state, and it became a national monument in 1870. Today the palatine city is alive again, with a court of officials at its service, a bureaucracy that keeps it running, and strict entry protocols, as if we're foreign envoys bearing a message for the emir.

ONE OF THE MOST NOTABLE envoys to Spain is the reason so many know this corner of the world today. The writer Washington Irving was a diplomat posted at the American Embassy in Madrid when he visited Granada in 1829. That was 17 years after Napoleon's troops had decamped,

and what remained deteriorated from neglect. Rooms were plundered, the pools became washing areas, the courtyards were turned into corrals, and families who had nowhere else to go settled in the empty spaces. “It went from being a castle of kings to a refuge for outcasts, but it was always inhabited,” says Bermúdez. “And that kept it standing.” The squatters of the Alhambra, Bermúdez calls them.

Irving gave them a more romantic name: the children of the Alhambra. It was the vagrants, the bandits, the disinherited who, together with the ghosts of the defeated, populated his *Tales of the Alhambra*—unveiling the city and putting it on the tourist map. Still in every bookstore in the city and widely translated, the book perpetuated the fortress’s romantic aura, reminiscent of *One Thousand and One Nights*. Other notables had set foot in Granada, but none had the impact of Irving. Given the weight of his influence, his single statue, set just off the Cuesta de Gómerez, a historic path to the fortress, seems a lukewarm tribute.

When Irving arrived at the Alhambra with his traveling companion, a Russian diplomat, they were appalled that visitors, even dignitaries, had left their mark in graffiti—their names and notes scrawled on its walls. The Russian provided a leatherbound guest book to discourage the practice. Thousands of signatures filled that volume for the next 43 years. It was an early glimmer of recognition of the structure’s value.

Though his fellow traveler soon departed, Irving would stay on for several months, “spell-bound,” he wrote, “in this old enchanted pile.” He ensconced himself in royal chambers that opened up onto picturesque Lindaraja garden. Mateo Jiménez, a self-described “son of the Alhambra” who claimed his ancestors had lived in the fortress for generations, offered himself up as a servant and guide, recounting the family lore.

Places where Irving set his reflections and accounts still can be seen today, such as the reconstructed Gate of the Seven Floors. Popular legend holds that Boabdil, the last sultan, fled through that gate, imploring that it be sealed after his departure. Irving’s story describes a succession of passages in which the sultan would have hidden a magnificent treasure in case he ever managed to return. Another spot, the Tower of the Princesses, later renamed after Irving’s tale, was the setting for his story of three Muslim princesses who fall for Christian captives.

ONE MIGHT EXPECT A CHRISTIAN QUEEN TO REDUCE THE ALHAMBRA TO ASHES. INSTEAD, ISABELLA ORDERED IT TO BE LEFT UNTOUCHED.

The book made the fortress “an object of desire—a need to visit it, to discover it,” says Bermúdez. “Today we know this is also part of our heritage. Preserving a universal monument such as the Alhambra also means preserving all the values from its past.”

THE ALHAMBRA HAS ALWAYS enraptured those from the outside. In January 1492 Queen Isabella, leading a military procession, began her triumphant ascent up Cuesta de Gómerez on horseback to Al Hamra, which translates to “the red” for the fortress’s pink-hued stone. The Reconquest—lasting more than 700 years—had rolled back Muslim territories one by one across the peninsula. A papal order authorized this final crusade, resulting in a 10-year war waged for control of the holdout Granada kingdom.

When the keys to the Alhambra were finally surrendered, chroniclers noted Isabella’s surprise as she took in the fine details inside the bastion that had long been forbidden to her: its intricate latticework, honeycombed vaulting, the infinite geometry of its tiles, trickling pools that mirrored the magnificent facades.

The Alhambra had been an impregnable fortress for almost three centuries. One might expect a Christian queen to reduce it to ashes, erasing from its walls the inscriptions praising Allah. Instead, she ordered that it be left untouched. What's more, she determined it would be her destiny for eternity, something that the unfortunate Boabdil could not fulfill: "I will and command that, if I should die outside the city of Granada, my entire body be taken, as it is, without delay, to the city." When she died in 1504 at her residence in the town of Medina del Campo, her coffin was sent on the three-week journey to Granada. The Alhambra, emptied of its Nasrid court just 12 years before, would be the final resting place of the Catholic queen. (Initially interred in the fortress, her remains, along with those of her husband, King Ferdinand, were later transferred to the Royal Chapel of Granada.)

While on his honeymoon several years later, King Charles V, Isabella's grandson, visited the city conquered by his grandparents. Grasping the symbolic value, he set out to designate his own palace in the Alhambra. Construction took more than a century, and the king never lived there, but Bermúdez considers that beside the point. It superimposed a new narrative: Charles used the original architecture as a base to build anew, a metaphor for triumph. And "placing himself just that little bit higher," Bermúdez says. Standing adjacent to the three Nasrid palaces—the Mexuar, the Comares, and the Palace of the Lions, collectively the undisputed jewel in the crown for visitors—the square, rigid structure built for the Spanish king was likened to "a meteor" by one architect.

Inside the central colonnade of Charles's palace, Bermúdez pulls out a key the size of his forearm and opens a door to a stone staircase. The "stairway of time," the Alhambra staff calls it. We descend in semidarkness to another gate. My eyes struggle to adjust before I'm dazzled by bright light. Bermúdez wields a new key and, as if enchanted, I'm suddenly standing in the Courtyard of the Myrtles, named for the bushes that surround its rectangular pool, in the Comares Palace. Yes, a bit lower than Charles's.

In a moment we transitioned from Renaissance sobriety to a saturation of the senses, from the victors to the vanquished. The staircase, built in 1580, was intended to do precisely that: to unite the old royal house with the new one.

Tourists view our sudden apparition as if we were ghosts from the past. With a mischievous smile, Bermúdez closes the door behind us.

SOME TWO MILLION PEOPLE visit the Alhambra each year, but they're limited to about 20 percent of the site. Bermúdez guides me through some of the hidden parts, namely an underground network. These are modest and functional rooms, he says, kept out of sight as they were back then, the domain of servants and guards who kept the palace running. Some also held prisoners. We peer into one of the complex's 20 dungeons, which was discovered just over a century ago. After the fall of Granada, the queen herself rushed to free Christian prisoners, as she had done in the Muslim stronghold of Málaga, where an officer from the Netherlands told her he'd been held for more than 40 years.

Still in the bowels, we make our way to a large cistern, which more readily resembles a cathedral with its barrel-vaulted naves and sheer size. The underground structures also provided a cool, stable temperature to store grain and other staples. As we descend by ladder into a cavelike silo, it strikes me as the place where the Alhambra's legendary passageways could begin. I instinctively search with my headlamp. None are here, but they do exist. One level up, members of the royal guard would have been posted beneath the throne room in the Comares Tower, ready to intervene in a crisis. We walk through the tunnels, aware that tourists marveling at the magnificence of the room cannot imagine the infrastructure that lay beneath.

Bermúdez unlocks a door. A flashlight illuminates a staircase that leads deep into the earth and, after 200 steps down, to yet another door. It opens into the heart of the woods, just outside the walls. We're a short distance from the Darro River. It would have been an easy—and clandestine—way to leave the fortress. In 1359 Muhammad V, the eighth Nasrid monarch, was ousted by a revolt that put his half brother in his place. In the middle of the night, rebels scaled the walls and knifed the guards. Barely 20 years old, the rightful sultan escaped—some say through a passageway in the Comares Tower. Was this the place where he would have arrived breathless and been spirited away?

The coup was a game of thrones involving changing loyalties, including that of his Christian ally Peter of Castile. After three

SPAIN'S MUSLIM ERA

In the eighth century, an army of Arab Muslims crossed into the Iberian Peninsula, ousting Germanic Visigoths. Known as Al Andalus, their new land faced constant pressures yet became a hub of arts, education, and science for centuries.

Balance of power in the 11th century
CHRISTIAN KINGDOM
MUSLIM KINGDOM
Settlement Fortification

BRIDGE TO EUROPE

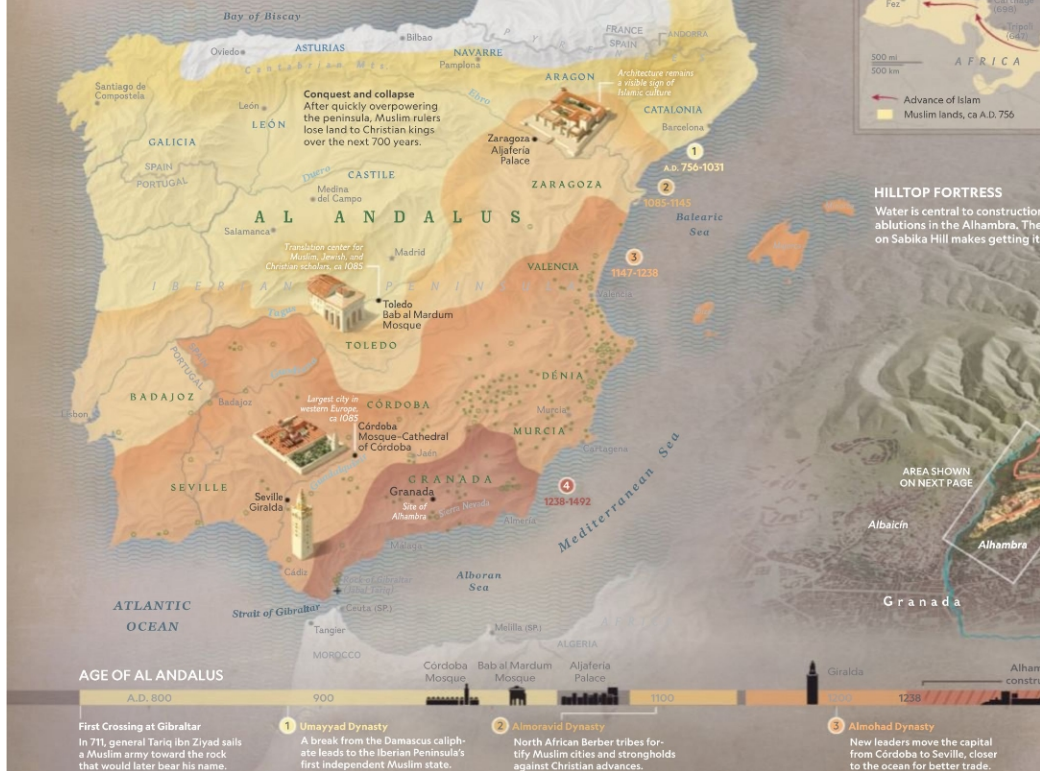
Islam spreads from its birthplace in the Arabian Peninsula, in 632, to North Africa and across trade routes. Defeat in France



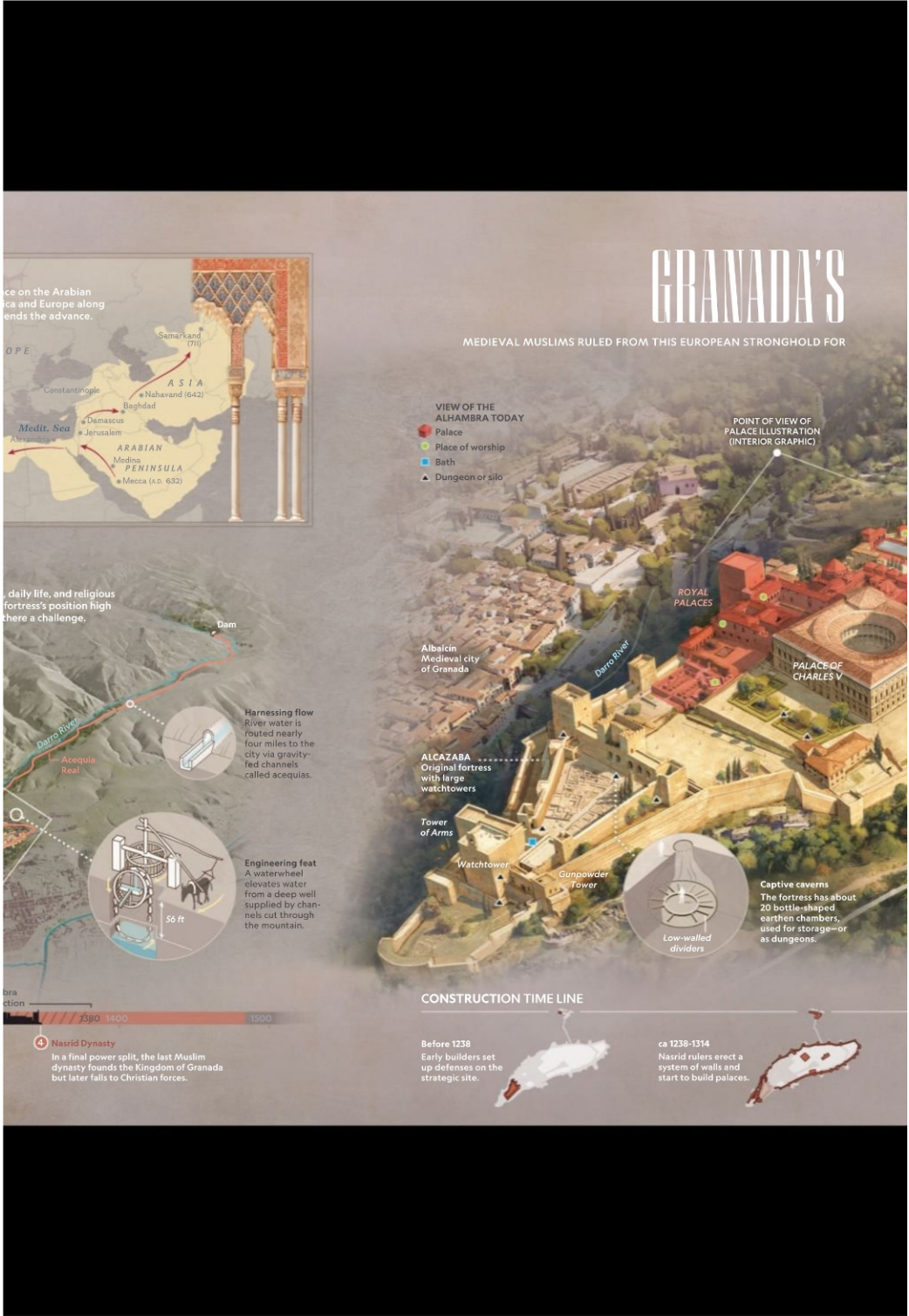
Conquest and collapse
After quickly overpowering the peninsula, Muslim rulers lose land to Christian kings over the next 700 years.

HILLTOP FORTRESS

Water is central to construction ablutions in the Alhambra. The on Sabika Hill makes getting it



ARTICLE

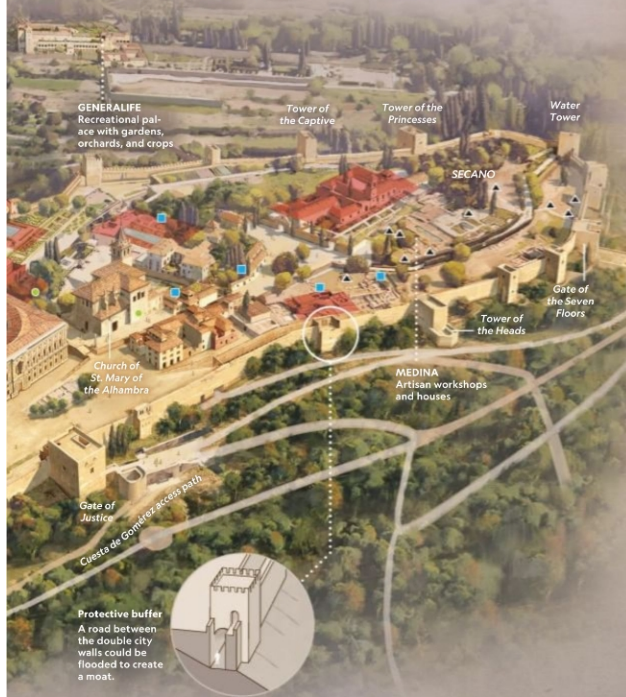




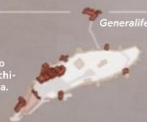
ARTICLE

ROYAL OASIS

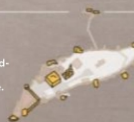
NEARLY 260 YEARS, LEAVING A LEGACY OF ARCHITECTURAL GLORY.



ca 1314-1391
Palaces evolve into the Alhambra's architectural golden era.



16th century
Christian-era buildings include King Charles V's palace.



2 ARTICLES



The throne room of Comares Palace showcases tile in geometric patterns—a hallmark of Islamic design—as well as elaborate plasterwork and inscriptions, originally painted in bright colors. Phrasing is woven into the honeycombed arches in the decorative Kufic style of Arabic, hiding in plain sight. Above, the band of legible cursive script (which continues vertically on the adjacent wall) honors the throne room, personified in the poem: “She, the central one, is like the heart.”

VISITING GRANADA

The city's rich heritage offers unique experiences for visitors.

THE ALHAMBRA

Book tickets at least one to two months ahead. General admission allows access to the Alcazaba, Nasrid palaces, Partal, and Generalife. The visit is mostly outdoors, making spring and fall ideal times. Don't miss the Courtyard of the Lions fountain and the Courtyard of the Myrtles, with facades reflecting in its pool. (King Charles V's palace, home to two museums, may be visited without a ticket.)

The **Monastery of San Francisco**, where monarchs Isabella and Ferdinand were initially interred, is now a hotel and restaurant that serves cuisine based on Nasrid court recipes.

ALBAICÍN

In this winding **old quarter**, once the center of Granada's Muslim life, boutique hotels occupy villas from the Nasrid dynasty's era. Our pick is the 18th-century **Hotel Casa Morisca**. (An alternative to the Albaicín's steep streets is the centrally located **Palacio de los Patos**, a 19th-century magnate's mansion.) At **Carmen de Aben Humeya**, diners take in a view of the Alhambra from within its walled garden, a distinguishing feature of traditional *carmen* dwellings. The **San Nicolás** lookout and the adjacent mosque gardens are classic spots for watching the sun set over the Alhambra. End the evening with a stop for tea on **Calle Calderería Nueva**.

SACROMONTE

Nearby **Sacromonte** is the birthplace of **flamenco**, a dance created by the Romany community, settled here for more than 500 years. Many live in the area's characteristic caves, where Muslims took refuge after the fall of the city (and some say also influenced the music of the dance). Cave bars now host performances, including **Cueva de la Roca**. A scenic walk to the neighborhood passes through **El Paseo de los Tristes** and **La Carrera del Darro**, along the river. —EL

ARTICLE

years, Muhammad V returned to his throne. Without that subsequent prosperous and peaceful 30-year reign, the Alhambra as we know it today would not exist. Muhammad ushered in the dynasty's golden age. He built what many consider to be the most striking spot in the Alhambra—the courtyard with a central fountain ringed by a dozen lion statues—and he continued his father's tradition of embellishing palaces with another art form: Arabic inscriptions.

THE ALHAMBRA IS A PALACE OF POEMS, an architecture of words, says José Miguel Puerta Vilchez, author of *Reading the Alhambra*, which decodes the inscriptions on its walls. Like Bermúdez, he's spent his life studying this place and translating it to the world. "If it lost its supports, columns, and arcades, the building would be held up by words alone," he says, referring to its ubiquitous calligraphic panels. Leaning on his knowledge, I see a different Alhambra—with the language barrier, one that remains largely inaccessible to those who inherited it. Verses run along its walls, curl in cartouches, and even meet in the closets. Some are carved in plaster, others in wood, or meticulously inscribed on tiles. The

omnipresent motto of the Nasrid house, "There is no conqueror but God," alternates on the walls with greetings for visitors, including *baraka* (blessing), *afiya baqiya* (perpetual health), and *yumn* (fortune).

In reality, the Alhambra was designed to praise God—and the sultan, as God's earthly representative. The ornamental script envelops visitors as if they were inside a monumental book. But the power of the written word didn't end there. The Diwan al Insa, the office of correspondence and records, was created around 1273 and run by a master of two nuanced arts: diplomacy and writing. "His function was propagandistic," says Puerta Vilchez. "The texts had to be not only correct but beautiful, poetic, capable of praising God, the dynasty, and the sultan." The person with the best command of language, the *katib*, became a double vizier—head of that office and prime minister—the most powerful man in the kingdom after the sultan.

Puerta Vilchez regards the kingdom's great poets as if he had worked with them himself, composing verses or transcribing internal documents that serve as invaluable chronicles of a tempestuous era. In his view, it's the swan song of the dynasty, aware of its geographic isolation on the peninsula and the inevitability of its fall. Written mainly by three successive poets who headed the chancellery in the 14th century, the Alhambra's epigraphs represent some of the Nasrids' most dazzling contributions to Islamic art—perhaps an attempt to demonstrate a grandeur that was not going to last much longer. Of the two forms of Arabic used, the *naskhi*, or cursive, is easily visible, but the Kufic form may go unnoticed even by a visitor who knows the language. With a rectilinear style, it can masquerade as a geometric element, blending into the decor.

In the Palace of the Lions, poet Ibn Zamrak and Muhammad might have had their boldest collaboration. Its fountain, magnificently sculpted so that the rock grain simulates the lions' muscles, contains a symbolic message. It features the word "caliph," Islam's highest leader, whose role transcends that of sultan. The change in title imbued Muhammad, a political figure, with religious authority—an impeccable example of 14th-century PR. "Those were difficult times," says Puerta Vilchez. "The sultan needed to legitimize his power not to Christians so much as his own people."

THE ONE WITH
THE BEST COMMAND
OF LANGUAGE
BECAME THE MOST
POWERFUL IN
THE KINGDOM AFTER
THE SULTAN.



A large silo not only stored grain but also served as a dungeon—one of 20 found in the complex. Captives were lowered by rope into a hole, where they would await ransom or prisoner exchange. As the conquest by a newly unified Spanish monarchy gradually rolled back the Muslim kingdom's territory, Christian prisoners became more common, though sometimes those held here included members of the sultan's own court.

ARTICLE

THE SAME PALACE ALSO HOLDS a rare artwork in the Hall of the Kings, which after a two-decade effort has just been restored to its former glory. Three painted scenes include human figures, atypical in Islamic art. But that's not the only enigma. Presiding over the central dome, 10 men dressed in luxurious Muslim-style garb appear to be watching over the space. One theory maintains they're the first 10 Nasrid rulers (hence the room's name). Two other paintings depict medieval court vignettes in which Christian and Muslim knights hunt, joust, and rescue maidens. (Muslims always win in these scenarios.) "At least two royal weddings took place in the Hall of the Kings," says Puerta Vilchez. "These paintings extolled the splendor of the Nasrid court and were meant to be seen." The 14th-century works were eventually hidden when the room was absorbed into a 16th-century church. Over time, they deteriorated.

The original canvases were made from horsehide tanned with alum and embellished with natural tempera pigments, then attached to wooden frames shaped like inverted boat hulls and covered with tar and plaster to prevent water or fire damage. "Artisans from different trades were involved—specialists in wood, painting, and leather. Together they created a masterpiece whose execution technique is unknown in the Spanish-Muslim world," says Elena Correa, who heads the Alhambra's restoration department.

A collection of architects, master plasterers, carpenters, and painters has worked hand in hand to repair the hall, presumably as the team that created this artistic jewel did 600 years ago. One achievement was inventing a restorative mortar that's imperceptible to the viewer. The stealth ingredient is quinine. "If we want to show a reconstructed segment, we have to use ultraviolet light," says Ramón Rubio, who leads the stucco and tile restoration workshop. The inspiration arose from an unexpected moment—when he observed quinine's fluorescence in a gin and tonic under disco lights.

Who were the painters of these scenes showing a last vestige of coexistence between Muslims and Christians before the fall of Granada? Experts say they could have been Christian artisans from neighboring kingdoms that commercially traded with the emirate—mainly those on the Italian Peninsula and particularly Genoa—or Muslims who knew the Renaissance techniques of those

Some 500 people care for the historic site, including 40 gardeners and more than a dozen highly specialized technicians for ongoing restoration. Here custodians attend to an arcade in the Generalife, whose name originates from the Arabic *Jannat al Arif*, or Garden of the Architect. Located uphill from the Alhambra, the palace was the sultan's private family retreat.

JUAN MANUEL CASTRO PRIETO,
AGENCE VU/REDUX



courts. Despite the arduous research involved in the restoration, in this place, as in so many others in the Alhambra, mysteries remain.

I LOOK OVER TO THE ALBAICÍN, Granada's labyrinthine medieval quarter, built on a hill opposite the Alhambra. With its whitewashed facades, villas, and hidden gardens of cypress trees, it's hard to imagine a more perfect view. I descend toward the Albaicín down a lane known as Cuesta del Rey Chico (Little King, Boabdil's nickname), departing as the 24th and last Nasrid sultan did when he left the fortress forever. Crossing




into that parallel world, I see the Alhambra as his subjects might have. From the Albaicín, the Alhambra's palaces can be read chronologically from right to left—like Arabic itself. The language can still be heard in the quarter, which is lined with tea shops and has the ambience of a souk. After Boabdil was deposed, residents were allowed to keep their businesses, homes, language, and religion, but that spirit of coexistence lasted only eight years. By 1501, Muslims were forced to flee or convert to Christianity.

I peer into the Dar al Horra Palace, the home of Boabdil's mother and his final refuge in

Granada, before he fled to Morocco. Nothing on the outside gives away its graceful interior. Like the Alhambra, the exterior reveals little. Beauty is unveiled only within. Before leaving, I pause for one last look. My friend Blanca Rooney, a veteran guide, is beside me. "I've seen it many times," she says. "It's the look of someone who is bidding farewell to the Alhambra as if they had just been expelled from it." □

Staff artist **Fernando G. Baptista** is from Bilbao, Spain, and previously illustrated Barcelona's Sagrada Familia. Other story elements were adapted from the magazine's Spain edition.

A photograph of a herd of caribou standing in a snowy, open landscape. In the background, a large, snow-covered mountain peak is visible under a clear blue sky. The scene is captured during the day, with soft lighting. The caribou are scattered across the lower third of the frame, some facing the camera and others looking away. The mountain peak is partially obscured by a layer of low-lying clouds or mist, giving it a ethereal appearance. The overall tone of the image is serene yet somber, reflecting the article's theme of declining caribou populations.

For millennia giant herds
of caribou have migrated
across North America.
But today they are dwindling,
and no one knows why.

BY NEIL SHEA

PHOTOGRAPHS BY KATIE ORLINSKY

ARTICLE

Where Have All the Caribou Gone?



ARTICLE



ARTICLE



CLYDE MORRY IS CHASING THE HERD HARD.

He jams the throttle down, spitting up a fine curtain of white crystals. I follow and can't keep up. I turn my own machine this way, that way, flailing over the same frozen ground, but I'm just not that good, and not as hungry as Morry is for the kill, the pounds of savory meat—or the warmth that will flow up into his hands as he butchers the big caribou. For some reason, even though it's 25 degrees, even though the April wind whipping through this mountain pass pushes the chill down further, Morry never seems to be wearing gloves.

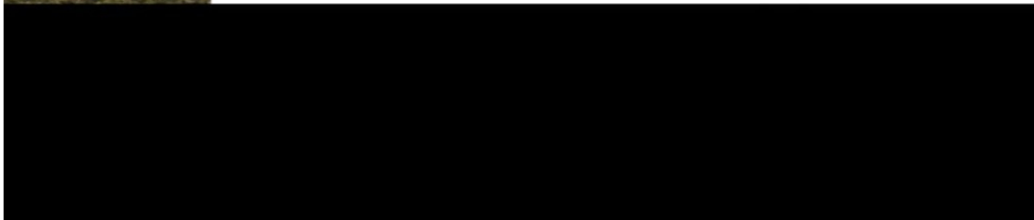
"Just slows me down," he says later.

Everything about Morry is quick—his temper, his basketball game, his work with a skinning knife. And this is no elegant chase: It's hot pursuit. Morry kicks through a few more turns, then skids to a stop, unslings his rifle, and takes aim. A shot like a popped balloon, small and hollow against the huge mountains, the empty sky. A hundred yards away a cow goes down. The rest of the herd, 10 or 15 mothers and their

LEFT: The Western Arctic caribou herd gathers on windy mountain slopes during the summer to avoid mosquitoes. Like most herds, the Western has experienced a stark and mysterious decline in recent years.

FLAP: Sniffing for scent, a bull caribou noses into the wind on the tundra. Caribou, members of the deer family, once roamed throughout the continent. Today they're found only in the northernmost reaches.

OPENING PHOTO: Caribou, or *tutu* in Inupiat, traverse the snowy heart of Alaska's Brooks Range. Each spring, caribou all across the North American Arctic begin extraordinary migrations toward their calving grounds.



ARTICLE



calves, keep running but not too far, as though they know the worst is over.

Morry and I drive up to the cow and see his shot has been clean. He slips out a knife from his black coveralls, bends over the body, gets to work. First, he severs her head. His people, the Nunamiut of Anaktuvuk Pass, Alaska, believe this and what follows are the most important steps. He carries the head a little distance away, gently, as though he were carrying a favorite cat, and places it just as gently in the snow, upside down. The cow's *inua*, her soul, may now escape and fly to the spirit world. There, a guardian

spirit will comfort the cow's soul and then send her to Earth again in a new body.

This is the cycle of respect and return and renewal. Morry is 37, and it's what he knows, what he was taught, and what he teaches his children. After the head is set, Morry begins butchering. Quick sharp strokes. Slick red hands. When his fingers get cold, he shakes them and blows on them and places them against the body to soak up some of its fading heat. When the meat is finally stacked onto a sled, he says, "Maybe I'll put on some gloves for the drive home."

He does, and drives back to Anaktuvuk Pass at

ARTICLE



Tlicho Nation members Joe Zoe (right), Janet Rabesca (left), and Tyanna Steinwand look for the Bathurst herd in a remote corner of Canada's Northwest Territories. The Tlicho have relied on Bathurst caribou for generations, but since 2015, with the herd's numbers spiraling, hunting them has been banned.

a much safer speed. This is not to say he drives slowly—he is mindful not to let the meat freeze. But this time I manage to keep up. Even, once, to pass him. As I do, I notice he's grinning. Morry has no job but this; he wants no job but this. Hunting is how he provides for his big extended family. And tonight at home there will be plenty of food and plenty of people gathering to eat it.

Morry's father will ask me, "Did you see him turn the head over?"

"Yes," I'll say.

The elder will nod. "Don't forget."

THE CARIBOU COW CLYDE MORRY KILLED belonged to the Western Arctic herd, sometimes simply called the Western. At the time, in early 2021, the Western was one of Alaska's largest groups of caribou. In the 1990s, when Morry was learning to hunt, the Western was on its way to a high of nearly 500,000 animals, and they roamed a territory about the size of California. Many of them walked right past Morry's house twice each year during their spring and autumn migrations, providing his community with a steady source of food and spiritual well-being in a roadless and extremely remote part of northern Alaska.

But by 2021, the Western's numbers had dropped by more than half. Some years, Morry and other hunters told me, very few caribou trickled through Anaktuvuk Pass. In other years, they arrived weeks late or didn't come at all. None of this was necessarily unusual—caribou herds have been known to fluctuate in size over time, and they are wild beings, heeding their own instincts, schedules, and motivations. Placed into a larger context, though, the decline is deeply unsettling because the Western is not alone.

Migratory tundra caribou can be called many things: barren-ground caribou or eastern migratory caribou in Canada, while in Alaska "caribou" alone will usually do. In Russia and Norway, nearly identical animals are called wild reindeer. All of these live in extreme northern habitats between the tree line and the remote reaches of the Arctic tundra, and they make long migrations. No matter where you look or what you call them, they have been fading away for decades right before our eyes.

Between the late 1990s and 2018 these animals declined by some 56 percent, from about five million to two million. After 2018, data on Russian reindeer (as well as collaboration with Russian scientists) were harder to come by, but in North

Caribou on the Move

Dozens of tundra caribou herds have long roamed across the upper reaches of North America. Some of these herds make the lengthiest migratory circuit of any land mammal—more than 800 miles when measured in a straight line. But recently, caribou numbers have declined dramatically, for reasons scientists are trying to unravel.

North American migratory tundra caribou (*Rangifer tarandus*)

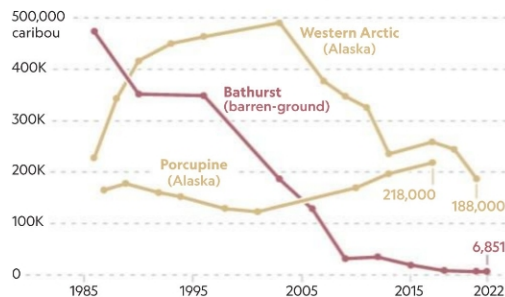
Subspecies ranges

Alaska *R.t. granti* Barren-ground *R.t. groenlandicus* Eastern migratory *R.t. caribou*



Plummeting populations

Western Arctic and Bathurst numbers, 15 percent of all migratory tundra caribou today, have been falling for decades. The Porcupine herd has seemed stable; its habitat has less mining development and more protection and food options.



Bathurst seasonal journey

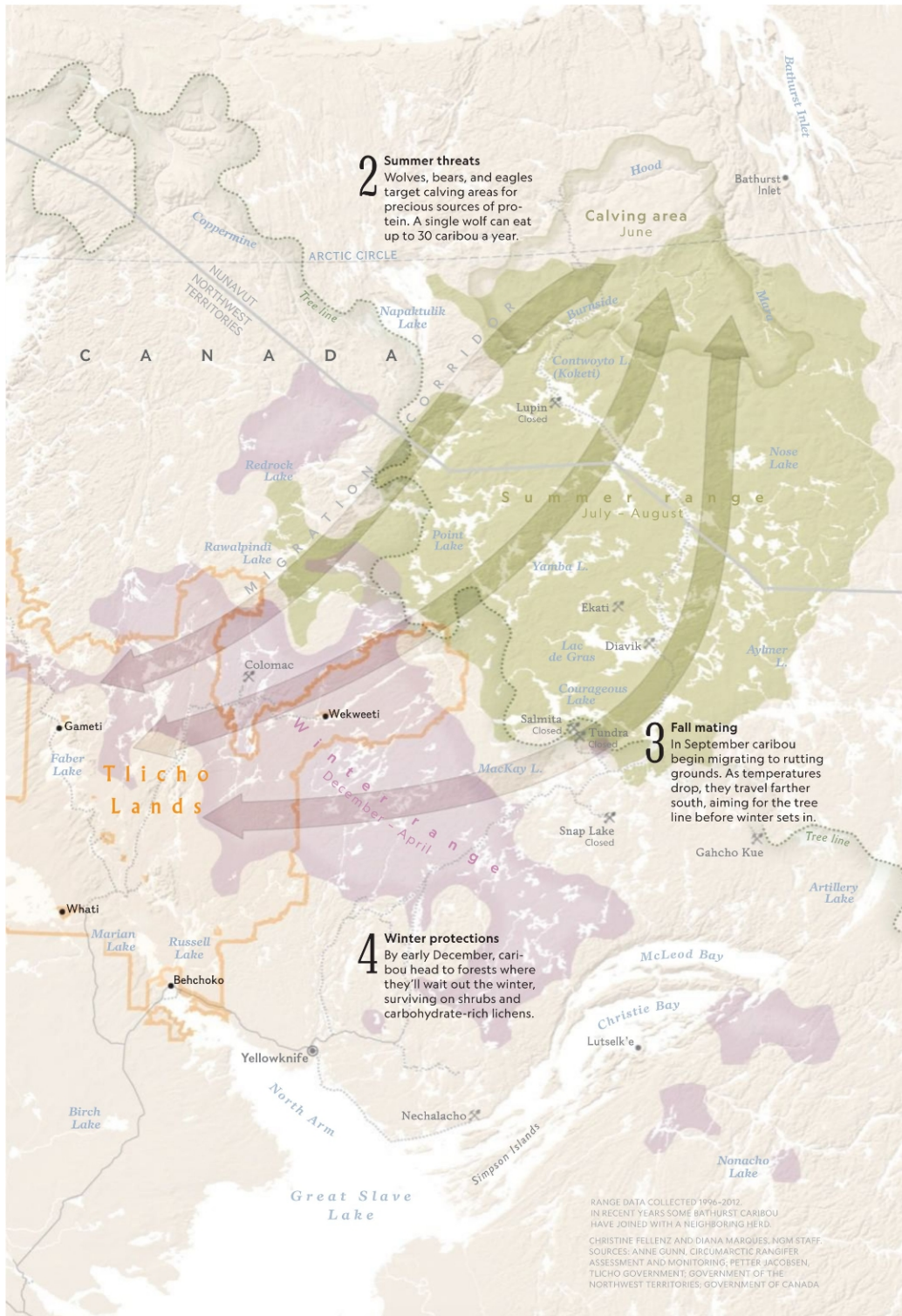
The herd is increasingly disrupted by development, such as mining roads. A warming climate also has impacts: more violent storms and insects, and more species moving north earlier in the year, including predators.



Stewards of the herd

Nomadic ancestors of the Tlicho Nation followed caribou. In 2015 the Tlicho halted their hunting to focus solely on conservation.

ARTICLE



ARTICLE



ARTICLE



LEFT: Nunamiut hunter Daniel Morry holds the still-warm heart of a caribou shot near his home in northern Alaska. Keeping with tradition, Morry will distribute the meat in his community, starting with the elders.

TOP: A skeleton picked clean by predators marks the route the Western Arctic herd takes through the Brooks Range at Anaktuvuk Pass, which in Inupiat means “the place of many caribou droppings.”

ABOVE: Clyde Morry, Daniel's uncle, prepares to haul a kill home with his snowmobile. His grandparents were part of the last Nunamiut who followed caribou, until about 1950, when they settled in this area.

ARTICLE

America the fall continued. Of about 13 major herds in Canada and Alaska, most have suffered steady losses, and at least one, called the Bathurst, has disintegrated to the point where it may disappear completely within a couple of years.

There's no consensus on what's behind this great vanishing. No disease has been pinpointed, no individual culprit gets the blame. No remedies or policies seem able to stop or even slow it. To anyone who lives south of the Arctic Circle the problem can seem abstract—another distant note of sadness in an era heavy with extinctions. But this is not how it appears in the far north.

In small communities scattered along the tree line or set in the open tundra, towns such as Anaktuvuk Pass that are often isolated, often Indigenous, where imported food and gas can be astronomically expensive and hunting caribou is often the cheapest and fastest and certainly the most satisfying way to provide for a family, the decline brings a peculiar dread. An Inupiat elder in a coastal town told me it was like feeling the symptoms of a cold coming on. The cold arrives, and it lingers. You don't get over it. Then it worsens, until you become gaunt and haunted, until you're afraid it isn't a cold at all but something deeper. Something that's shot through your whole system.

This is how the caribou problem feels to many Native people in the north, including the Nunamiut. Their name means "people of the land," but anyone will tell you that they are, most of all, a caribou people. They are also sometimes called America's last nomads, because only in about 1950 did the Nunamiut give up a mobile life, a life spent hunting and following caribou. They chose to settle in Anaktuvuk Pass exactly because the herd poured through it like a river. The name Anaktuvuk means "the place of many caribou droppings."

One night after I'd gone out hunting with Clyde Morry, his father, Mark, made a quiet comment about the choice his people had made. Mark Morry was a veteran of the Vietnam War. Thick gray hair, thick old glasses. He sat in a recliner by a window in the house he had built, watching his family eat caribou that Clyde had brought home.

"It was a big gamble for them to settle down like that," Mark said of his own father and mother and uncles and aunts, the generation who gave up nomadism. "They figured the caribou would always be here."



Nunamiut elder Raymond Paneak (seated left) teaches pupils to butcher a 400-pound caribou and process its hide at Anaktuvuk Pass's school. The class is part of a community effort to pass traditional skills on to younger generations. Paneak died several months later, at age 81.



WHEN WILDLIFE BIOLOGIST HEATHER JOHNSON arrived in Alaska several years ago, she was surprised to discover how mysterious caribou still were. Like other northern creatures—polar bears, say, or narwhals—caribou live what writer Barry Lopez once called obscure lives. They can be hard to find. Expensive to study. They spook easily. Even what they eat has been, at times, difficult to pin down. This is a major reason their decline is so puzzling.

“I didn’t think there was a terrestrial large mammal left in North America that we didn’t know much about,” said Johnson, who works for

the U.S. Geological Survey. “I thought, how can we possibly know so little about these animals? But then an older colleague said, ‘Heather, you’ve got to flip that around: You should be impressed that we know even as much as we do.’”

Consider, for example, that only recently did researchers confirm that caribou are among the planet’s greatest wanderers. Using data from satellite tracking collars, a team led by Kyle Joly, a wildlife biologist with the National Park Service, showed in 2019 that the animals can travel more than 800 miles each year—in point-to-point, straight-line terms—on their migratory circuit.

WHERE HAVE ALL THE CARIBOU GONE? 125

ARTICLE



Casey Edwards carves up a fresh caribou in her kitchen alongside her one-year-old daughter, Ellie Lu. Caribou remains a crucial source of affordable protein in Anaktuvuk Pass, which is located off the road system. Practically all other groceries are flown in and are expensive.

ARTICLE



ARTICLE

That's farther than all other terrestrial mammals.

During these epic journeys caribou may navigate between dark spruce forests and sun-bleached tundra, or from bleak mountainsides to wind-blasted coastal plains. They've even been known to walk into the sea. They also face an array of natural hazards—wolves, bears, ice-choked rivers, galactic swarms of mosquitoes, and life-draining parasitic flies—as well as an ever increasing set of human-made obstacles: oil fields, roads, and mines.

Climate change, too, is rapidly transforming their habitat. Rising temperatures across the Arctic now routinely disrupt familiar weather patterns. Where snowstorms were once the signature weather event of an Arctic winter, freezing rain is becoming more common, locking caribou forage away under impenetrable lids of ice. Summers are also growing longer, which isn't necessarily a good thing: Warmer temperatures bring new plants and animals, more parasites, and even wildfires to the tundra.

All these forces affect caribou in ways we've only begun to unravel. What it means is that if you're a scientist, a hunter, a conservationist, or anyone who comes looking for a reason for the vanishing, you'll suddenly find yourself staring into a problem as big as the landscape itself.

"I THINK BY NOW IF THERE WAS JUST ONE THING, we'd know it," said Jan Adamczewski, a Canadian biologist. "But when you draw up a list of all the things that might be affecting caribou, it can be a very long list. And when you draw up a list of things you can do about it, it's usually a very short list."

Adamczewski works for the government of the Northwest Territories, which is home for at least part of the year to seven migratory tundra caribou herds. This includes the Bathurst—the one that has come to represent a kind of worst-case wildlife scenario. In 1986 the herd numbered 472,000 animals. From there it began a gradual decline that eventually tumbled toward collapse. By 2021, the herd had dropped 99 percent.

The fall was extraordinary, and when I asked Adamczewski what might be behind it, he sighed. He was used to the question—often posed by people who'd already arrived at their own conclusions. Adamczewski told me that many people he spoke to believe climate change had something to do with the herd's decline. But the term was vague, the effects hard to parse.

It was a lot easier, Adamczewski said, to zero in on smaller, more discrete suspects. Wolves were a popular villain. Other people believed hunters were killing too many animals. And within the Indigenous communities that make up nearly half the territory's population—and that stand to be most affected by caribou loss—mining was often seen as the greatest threat to the herds, Adamczewski said.

Around the time the Bathurst seemed healthiest, a handful of mines opened in the Northwest Territories, including Colomac, a gold mine, and Diavik and Ekati, both diamond mines. All of them sprawled across the home range of the Bathurst, and Lupin, an older gold mine, lay due south of their calving grounds in Nunavut.

"Everyone around here knows that the Bathurst were at their peak [then]. And then the mines came and roads were built, and the caribou started to decline." For many people, Adamczewski said, it was no coincidence.

Several studies have shown that industrial development disrupts caribou behavior. The animals often seem to perceive roads and pipelines in particular as obstacles blocking their migratory paths and feeding patterns. They also tend to avoid mining camps and oil fields, which can leak chemical odors and tailings, shake the earth with drilling equipment and truck traffic, and fill the air with the racket of planes and helicopters.

While mining in the Northwest Territories will almost certainly carry on no matter what happens to the Bathurst (the territory is heavily dependent on the industry, which provides thousands of jobs and millions of dollars in revenue), Adamczewski said the territory and several First Nations had attempted other approaches to halt the Bathurst's hemorrhaging. In 2015, he said, the territory established a controversial hunting ban, which was supported by local Indigenous communities. The territory has also tried to reduce wolf numbers by, among other things, shooting them from aircraft. Still the herd shrank.

ONE OF THE MOST HAUNTING CONSEQUENCES of decline, for the Bathurst itself, appears to be an increasing loss of identity. In caribou biology, the term "herd" usually refers to a group of animals that all return to the same place to give birth—the same calving grounds. Mothers teach their young how to navigate there, show them different feeding spots along the way. They also share

Caribou live obscure lives. They can be hard to find. Expensive to study. They spook easily.

alternative routes, detours that might be useful depending on what the weather or the wolves or the human hunters are doing.

I've long thought these migrations resembled pilgrimages. The education of younger animals (delivered mostly by older females) is connected to what scientists often call the herd's collective memory: its unique and enduring way of knowing the landscape. Some have even begun to call such practices culture. These cultures are cohesive enough that the animals tend to stick with their own and remain loyal to their calving grounds.

But Adamczewski said that in recent winters the Bathurst had been mixing with another, much larger, herd called the Beverly. Maybe the Bathurst caribou were seeking safety in the Beverly's numbers. Maybe they would fold into the larger herd. It was still possible for them to recover; other herds had come close to disappearing and scraped by. But the Bathurst's singular culture—its way of *being*, as an Indigenous friend had put it to me—was at risk of blinking out.

"If we lose one of these herds, there's a lot in terms of behavioral memory that we also lose," Adamczewski told me. "When caribou don't visit their traditional calving grounds, they don't seem to live as long."

Seen against other changes unfolding in the far north—greening tundra, melting sea ice, burning forests—the unraveling of the Bathurst appeared like a symptom of dementia, the landscape losing another piece of its identity. Would the Bathurst's condition spread? Was it irreversible? Was there a cure? No one knew.

Adamczewski said he found hope in small details: signs of growth in one herd, say, or a slowing rate of decline in another. Even holding on to a broader sense of time itself helped.

Caribou herds seem to follow cycles, he said,

phases of boom-and-bust during which they peak and then contract. Across Alaska and Canada, many herds, including the Western, bottomed out in the 1970s and then began to climb into the '90s and early 2000s. Indigenous oral histories record even earlier eras of plenty and of dearth.

If cycles do exist, their causes are unknown and appear to operate on decades-long intervals. The idea is attractive because it suggests caribou herds naturally bounce back. But it can also be misleading, many researchers warned me, because in a rapidly changing, warming world even the most durable creatures may not have enough time to recover.

"There are times when we do lose herds on the landscape, and there are times when new herds will be forming as well," Adamczewski told me. "Herds are not immortal. They're not fixed forever in time and space."

ON AN OVERCAST DAY IN AUGUST 2021 I STOOD on a green tundra plain in an isolated corner of Nunavut, looking over dozens of caribou trails. They were deep and narrow, and they scored the earth in every direction, like rows of corn, like rays of light in a child's drawing of the sun. You could pick any of them and walk it to the horizon. Maybe all the way back to the city of Yellowknife, 250 miles to the south.

I chose a trail and followed, clumsily, slotting one boot in front of the other. Beside me a stout, athletic man named Roy Judas did the same. He wore woodland camouflage, though the nearest tree was more than a day's walk away. And he carried an old lever-action Winchester rifle, in case of bears, or "big men," as his people, the Tlicho, sometimes call them—a term of respect. On that day, though, the big men were absent, off hunting or munching cloudberries somewhere else.

Everywhere we turned, the tundra appeared



ARTICLE



Caribou navigate waterlogged tundra in June as they head to summer grazing grounds. They are born swimmers thanks to buoyant hollow hair follicles and paddle-like hooves, which help them cross rivers, streams, and lakes during their migration.

ARTICLE

empty. We were near the calving grounds of the Bathurst; the old trails were probably theirs. But the caribou were absent too.

While I walked, I tried to imagine the volume of animals required to shape the landscape this way—to impress their passage so firmly. Tens of thousands of caribou. Decades of migrations. The earth thrumming under their spadelike hooves.

“Used to be a highway for them,” Judas said. “All gone now.”

Like Clyde Morry in Anaktuvuk Pass, Judas had grown up hunting caribou in the forests near his home in Wekweeti. His mental maps of the landscape, as well as his people’s language and culture, were flecked with caribou-related landmarks, stories, vocabulary. Skins from Bathurst caribou had once been their most valued resource. In the form of tents, equipment, and clothing, they made human life possible along the cold frontier where the great northern forests faded into open Arctic tundra. Some Tli-cho told me they could even taste the difference between Bathurst caribou and animals from other herds.

Judas could no longer hunt the Bathurst, of course: The Tli-cho, a First Nation, had abided by the territorial hunting ban. But this decision, he and others told me, had not been easy. By that time the Tli-cho (sounds similar to CLEE-cho) had already suffered from decades of colonial practices, including language and cultural loss. The collapse of the Bathurst only deepened a sense of existential crisis. If the Tli-cho couldn’t hunt the Bathurst, if they couldn’t maintain traditions and ancient bonds with the animals, who would they themselves become?

The Tli-cho were still wrestling with the question when I joined Judas and several other Tli-cho citizens on the shore of Koketi, also called Contwoyto Lake. One of the nation’s answers had been to create a program called Ekwo Naxoehdee Ke, which means, roughly, “following in the trails of the caribou.” (It’s also known as Boots on the Ground.) For part of each year Judas worked for the program, leading groups of Tli-cho citizens to Koketi, where they spent weeks camping, hiking, and searching for remnants of the herd.

“When we find them, we take notes,” Judas said. “We watch them, we follow them. We try to get close and figure out what they’re up to.”

The observers counted caribou and recorded other details, including how they looked, where they were traveling, what they were eating, and



Southern mountain caribou browse for lichen in an enclosure in south-central British Columbia. A consortium of First Nations captures and collars pregnant females to help restore the imperiled subpopulation.



who was eating them. At the end of every summer, the results were returned to the Tlicho government, which used them to guide management decisions for the Bathurst.

"The main reason for creating that program was for our own Tlicho people to be the eyes and ears of what's happening out there with the caribou," said Tammy Steinwand-Deschambeault, director of the department of culture and lands protection for the Tlicho government. "The elders didn't want to rely on the territorial government or anybody else to say, 'This is what's happening; this is what we're seeing.' The elders

said, 'We need to see for ourselves. So let's get out there.'"

Steinwand-Deschambeault told me the Boots program also had secondary goals: to expose younger Tlicho to language and hunting skills (if not hunting itself) and to keep contact with the Bathurst.

"If we're not on the land, the caribou think that they're not needed," she said, and they might decide to go away. "So we need to go back to being out on the land more, you know—attend to these kinds of relationships. We have to do our part."

WHERE HAVE ALL THE CARIBOU GONE? 133

ARTICLE

DURING THE TIME I SPENT WITH JUDAS AND HIS crew, we saw many animals. Enormous bears, trout as long as my leg, eagles, cranes, muskoxen, and a young white wolf that walked through our camp as though she owned the place.

We also passed through layers of deep human residence. Century-old campsites, hunting blinds built of stacked boulders that dated back to an era of arrows and spears. Often, when we paused to rest, we found our feet surrounded by “lithic scatter”—shards of stone left by hunters who’d long ago sat in the same spots, knapping tools from flint or quartz.

But there were very few Bathurst caribou. At the time, only about 6,000 animals were believed to remain. That number seemed large, at first. With a little effort, I thought, we couldn’t help but find the herd. Judas gently corrected me. It would be easy, he said, for so few animals to disappear into the belly of the tundra. As the days dragged on without many sightings, I began to grasp the scale of the problem.

I live in New York City. The closest wild migratory tundra caribou roam some 1,000 miles away in Ontario. Even for me, after years spent working on this piece, interviewing dozens of people and camping many nights in caribou country, the animals are usually out of sight, out of mind. Less like a fellow being and more a distant idea, a shadow drifting over the map. Multiply this conceptual distance across most of our lives, and you see why their fate doesn’t summon a sense of alarm in the capitals of Ottawa or Washington.

For Roy Judas the response was clear, and it was personal. In summer, he counted caribou on the tundra. In winter, when the Bathurst migrated back into the trees near his hometown, he worked for the territorial government helping to enforce the no-hunting rule. It was his way of respecting the animals. Of tending to the old relationship. And for a while it made him unpopular.

Back in 2015, when the ban took effect, not everyone had supported it. Some Tlicho resented the notion that outsiders were trying to control their herd. They wanted to keep hunting, as they always had, and occasionally Judas’s job forced him into uncomfortable conflict with neighbors. Once, he’d even caught an old friend hunting.

Late one evening on the tundra, as we tripped through caribou trails, Judas told me that people seemed finally to be coming around to his way of seeing things.

“What way is that?” I asked.

He swatted a mosquito, hefted his rifle to the other shoulder. “I want there to be caribou in the future,” he said.

HEAD WEST FROM THE LAND OF THE BATHURST, across the Northwest Territories and into the Yukon, toward Alaska, and you will find the outlier in this story. Here, touching the coast of the Beaufort Sea, straddling the international border, and reaching into the lands of the Inupiat and Gwich’in, lies the range of the Porcupine herd.

When I began this project, nearly every researcher I spoke with was quick to point me toward them. The Porcupine, they said, seemed to be bucking the continental trend. And it wasn’t that the herd had simply failed to collapse: Their numbers had recently increased.

Between 2013 and 2017, when the Bathurst were steadily shrinking and the Western soon would be, the Porcupine grew by about 21,000 animals to reach 218,000. This despite climate change, despite wolves. Despite everything.

For many scientists and hunters, this felt like hope. It wasn’t clear why the Porcupine were thriving while other herds declined all around them; as with everything caribou, the answer was likely hidden in the intricate weave of climate, biology, and landscape. But briefly it looked as though the Porcupine might hold a secret, some clue that could help illuminate, or maybe slow, the vanishing.

Lean on an outlier, though, and it often begins to shift. Heather Johnson, the USGS researcher, recently cautioned me not to make too much of the Porcupine’s numbers. The herd hadn’t been accurately counted for six years, she said, and in the meantime, hunters have observed worrisome trends in body condition: The caribou are increasingly in poor shape, packing less of the crucial fat that helps them survive brutal Arctic winters. “The idea that they’re not declining is kind of out of date,” Johnson said. “We really don’t know.”

Around the time this article went to press, in fall 2023, some people I spoke with were anticipating the release of new caribou surveys, which are usually done over the summer. The Western and Porcupine were both due for fresh counts, and an increase in either could boost the mood, even affect hunting regulations. On the other hand, bad numbers would only deepen the gloom.

Kyle Joly, the National Park Service biologist, told me it had already been a tough year for the Western. He’d spent part of July in northern

DURING THE TIME I SPENT WITH JUDAS AND HIS crew, we saw many animals. Enormous bears, trout as long as my leg, eagles, cranes, muskoxen, and a young white wolf that walked through our camp as though she owned the place.

We also passed through layers of deep human residence. Century-old campsites, hunting blinds built of stacked boulders that dated back to an era of arrows and spears. Often, when we paused to rest, we found our feet surrounded by “lithic scatter”—shards of stone left by hunters who’d long ago sat in the same spots, knapping tools from flint or quartz.

But there were very few Bathurst caribou. At the time, only about 6,000 animals were believed to remain. That number seemed large, at first. With a little effort, I thought, we couldn’t help but find the herd. Judas gently corrected me. It would be easy, he said, for so few animals to disappear into the belly of the tundra. As the days dragged on without many sightings, I began to grasp the scale of the problem.

I live in New York City. The closest wild migratory tundra caribou roam some 1,000 miles away in Ontario. Even for me, after years spent working on this piece, interviewing dozens of people and camping many nights in caribou country, the animals are usually out of sight, out of mind. Less like a fellow being and more a distant idea, a shadow drifting over the map. Multiply this conceptual distance across most of our lives, and you see why their fate doesn’t summon a sense of alarm in the capitals of Ottawa or Washington.

For Roy Judas the response was clear, and it was personal. In summer, he counted caribou on the tundra. In winter, when the Bathurst migrated back into the trees near his hometown, he worked for the territorial government helping to enforce the no-hunting rule. It was his way of respecting the animals. Of tending to the old relationship. And for a while it made him unpopular.

Back in 2015, when the ban took effect, not everyone had supported it. Some Tlicho resented the notion that outsiders were trying to control their herd. They wanted to keep hunting, as they always had, and occasionally Judas’s job forced him into uncomfortable conflict with neighbors. Once, he’d even caught an old friend hunting.

Late one evening on the tundra, as we tripped through caribou trails, Judas told me that people seemed finally to be coming around to his way of seeing things.

“What way is that?” I asked.

He swatted a mosquito, hefted his rifle to the other shoulder. “I want there to be caribou in the future,” he said.

HEAD WEST FROM THE LAND OF THE BATHURST, across the Northwest Territories and into the Yukon, toward Alaska, and you will find the outlier in this story. Here, touching the coast of the Beaufort Sea, straddling the international border, and reaching into the lands of the Inupiat and Gwich’in, lies the range of the Porcupine herd.

When I began this project, nearly every researcher I spoke with was quick to point me toward them. The Porcupine, they said, seemed to be bucking the continental trend. And it wasn’t that the herd had simply failed to collapse: Their numbers had recently increased.

Between 2013 and 2017, when the Bathurst were steadily shrinking and the Western soon would be, the Porcupine grew by about 21,000 animals to reach 218,000. This despite climate change, despite wolves. Despite everything.

For many scientists and hunters, this felt like hope. It wasn’t clear why the Porcupine were thriving while other herds declined all around them; as with everything caribou, the answer was likely hidden in the intricate weave of climate, biology, and landscape. But briefly it looked as though the Porcupine might hold a secret, some clue that could help illuminate, or maybe slow, the vanishing.

Lean on an outlier, though, and it often begins to shift. Heather Johnson, the USGS researcher, recently cautioned me not to make too much of the Porcupine’s numbers. The herd hadn’t been accurately counted for six years, she said, and in the meantime, hunters have observed worrisome trends in body condition: The caribou are increasingly in poor shape, packing less of the crucial fat that helps them survive brutal Arctic winters. “The idea that they’re not declining is kind of out of date,” Johnson said. “We really don’t know.”

Around the time this article went to press, in fall 2023, some people I spoke with were anticipating the release of new caribou surveys, which are usually done over the summer. The Western and Porcupine were both due for fresh counts, and an increase in either could boost the mood, even affect hunting regulations. On the other hand, bad numbers would only deepen the gloom.

Kyle Joly, the National Park Service biologist, told me it had already been a tough year for the Western. He’d spent part of July in northern

It wasn't clear why the Porcupine herd was thriving while other herds declined.

Alaska recovering satellite tracking collars from caribou that had died during a brutal winter that saw deep, wet snow—cement-like stuff that's hard for caribou to travel through. In September brighter news unfolded on the state's oil-rich North Slope where the Department of the Interior canceled all petroleum leases in the immense Arctic National Wildlife Refuge, home to the Porcupine's calving grounds.

The news was celebrated among the Gwich'in, for whom the area around the calving grounds is holy, "the sacred place where life begins." But human hunger for oil still looms over the Porcupine's future. While there's no drilling in the refuge now, there's also no guarantee a new administration, or a new Congress, won't push for it. Local and national politicians have already tried and failed dozens of times.

"I think it's been hard for us to quantify how much has been changing for caribou," Johnson told me. But "if there's one thing they don't like, it's industrial development. They are just really sensitive to development. It's been shown so many times."

In a mystery the size of a continent, she said, this may be the best lead we have.

CARIBOU ARE CREATURES OF HABIT, AND THEIR habits seem synced to an older and colder world that no longer exists. The question in our time is how quickly they will or won't adapt. Late one October I stood alone on the shore of the Kobuk River in western Alaska, watching a young male try to swim the black water. He struggled. Large rafts of ice tumbled down the current, battering him, shoving him under. A group of his less daring companions stood on the shore waiting to see how things would turn out.

The place was Onion Portage, and for 10,000 years caribou had been coming here to cross the

river at the end of their autumn migration. Artifacts show that for at least that long humans had been arriving to meet them, hunt them, process their flesh and hides and bones. It was a regular appointment, kept across millennia. And though local hunters still showed up, the caribou now were often late or didn't come at all.

The shifting migration brought consequences for both humans and animals. In the caribou's case, arriving later in the season meant finding a river in flux—not exactly liquid, not fully frozen. Crossing was dangerous, as the young male was learning. Waiting for freeze-up was too: Wolves and bears patrolled the forest along the riverbank. But the caribou had no choice. For days hundreds of them paced up and down the river, yards from my tent, filling the air with their musky scent and the peculiar *click click click* that comes as they walk, a sound thought to be made by tendons snapping over bones in their feet. They were restless and wanted only to continue their journey.

From my small vantage it seemed impossible the world would ever return to the way it had been when this route over the river, this habit of movement, was laid down in their ancestors' minds. Already the portage itself was being transformed by new trees and shrubs that had crowded in and grown tall as the climate warmed. But I'd been told by many Indigenous people that the caribou would adjust, given time. They were curious, resilient. In the Arctic they had to be.

I looked back to the river: a chunk of ice, a blow to the head, another dunking. The young male surfaced in a spluttering fit. He decided to turn around. At the shore he shook wildly, rejoined the others. The herd turned to regard me—gray bodies, big racks, eyes wide. Then the caribou stepped up the bank and disappeared into the trees. □

The Pulitzer Center provided a grant to support the reporting for this story.



ARTICLE



Caribou make their spring trek through the Kobuk River Valley near Ambler, Alaska. For more than 10 years, plans to build a 211-mile mining road have hovered over the region. The road will cut across the migration path of the Western Arctic herd, which in the past two decades has dropped from almost half a million to 164,000.

ARTICLE



Caribou make their spring trek through the Kobuk River Valley near Ambler, Alaska. For more than 10 years, plans to build a 211-mile mining road have hovered over the region. The road will cut across the migration path of the Western Arctic herd, which in the past two decades has dropped from almost half a million to 164,000.

ARTICLE



INSTAGRAM

BEVERLY JOUBERT

FROM OUR PHOTOGRAPHERS

WHO

A conservation filmmaker and photographer specializing in African wildlife

WHERE

Southeastern Kenya

WHAT

Sony Alpha 1 camera with a 600mm lens

A National Geographic Explorer at Large, Joubert was filming giraffes in Kenya's Chyulu Hills for an upcoming documentary. To get close without spooking the animals, she spent days in an underground blind near a watering hole. Giraffes came and went, but red-billed oxpeckers routinely stole the show. Swooping from one giraffe to the next, the industrious birds picked off ticks and other parasites, cleaned stray food from teeth, and plucked loose hairs for use in their nests. "Everywhere you look in the natural world," Joubert says, "there are fascinating examples of adaptation and interdependence."

National Geographic has more than 453 million Instagram followers. Join them here: [@natgeo](#), [@natgeotravel](#), [@natgeointhefield](#), [@natgeoadventure](#), [@natgeoyourshot](#), [@natgeotv](#), [@natgeowild](#), [@natgeodocs](#).



Animal Adventure Sweepstakes

Advertisement for Disney Destinations, LLC | To celebrate the 50th anniversary of the Endangered Species Act this month, National Geographic Kids is asking parents to send in their children's animal drawings for a chance to win a vacation to Walt Disney World, including Disney's Animal Kingdom. Plus, 10 runners-up could win a \$100 Disney gift card. For entry details and official rules, parents can go to [natgeofamily.com/sweepstakes](#).

NO PURCHASE NECESSARY TO ENTER OR WIN. SWEEPSTAKES BEGINS ON 11/17/23 AT 8 A.M. ET AND ENDS ON 12/15/23 AT 11:59 P.M. ET. OPEN TO LEGAL RESIDENTS OF THE 50 UNITED STATES AND THE DISTRICT OF COLUMBIA WHO ARE 18 YEARS OF AGE OR OLDER (OR THE AGE OF MAJORITY IN THE JURISDICTION OF THEIR RESIDENCE, WHICHEVER IS OLDER) AND HAVE CHILDREN BETWEEN THE AGES OF 5 AND 14 AT THE TIME OF ENTRY. VOID WHERE PROHIBITED. VISIT [NATGEOFAMILY.COM/SWEEPSTAKES](#) FOR FULL OFFICIAL RULES, ENTRY REQUIREMENTS, ELIGIBILITY RESTRICTIONS, LIMITATIONS, AND PRIZE DESCRIPTIONS. THE WALT DISNEY COMPANY IS MAJORITY OWNER OF NATIONAL GEOGRAPHIC PARTNERS.

ARTICLE

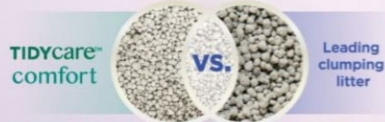
TIDYcare™

LITTERS DESIGNED WITH CATS IN MIND



comfort

Cat-Preferred* Design Supports
Healthy Litter Box Habits



Smaller Granules for Cat-Preferred* Paw Feel

*Compared to the leading litter

alert

Color-Changing Crystals
Help Monitor Cat Health



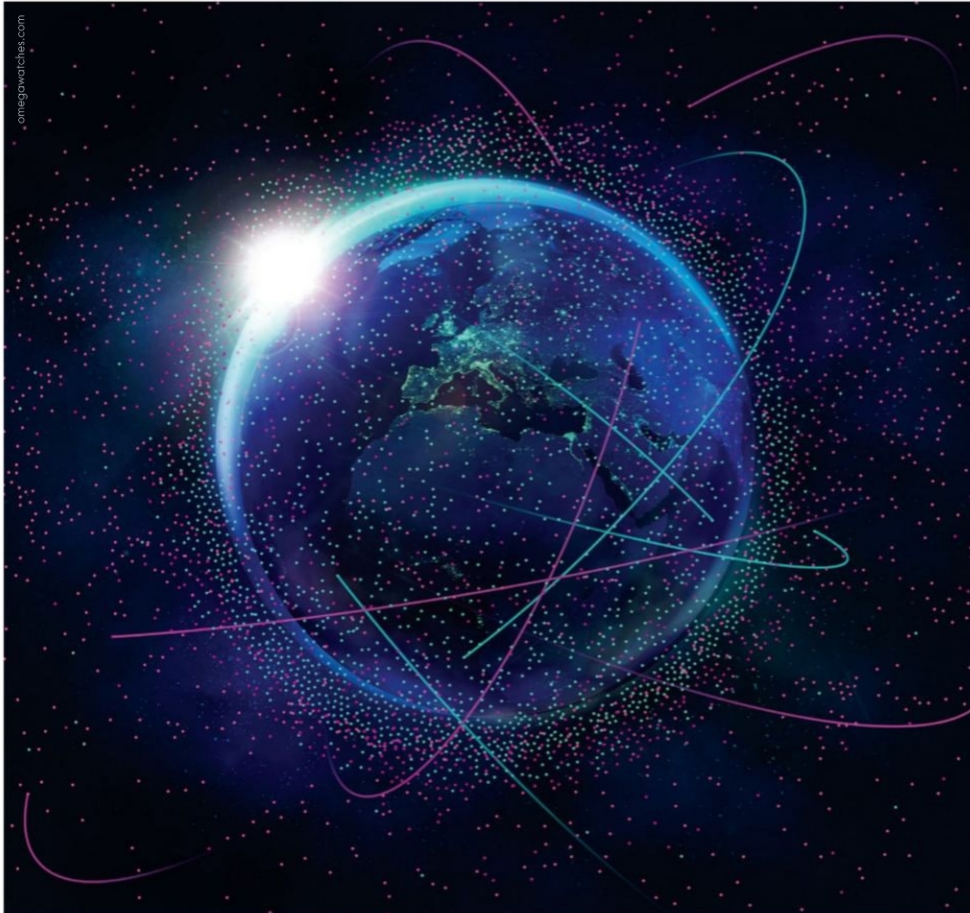
This litter is not a test to diagnose, cure, prevent, treat, or mitigate disease.
Discuss color changes with your veterinarian.



Purina trademarks are owned by Société des Produits Nestlé S.A.



Your Pet, Our Passion®



A MAP TO THE FUTURE



The future of space exploration is full of possibility. As innovation takes off, OMEGA is aiming for a sustainable tomorrow, where the path is clear in every direction. Continuing our proud legacy beyond Earth, we're now partnering with Privateer to keep track of the debris that currently surrounds our planet. By doing this, we can look confidently ahead, and ensure that nothing stops humanity from reaching the next frontier. Scan the code to learn more about the project.



PRIVATEER

Ω
OMEGA